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THE NATIONAL GEOGRAPHIC MAGAZINE

Triumph on Everest

I. Siege and Assault

BY BRIGADIER SIR JOHN HUNT, C.B.E., D.S.O.

Leader of the British Everest Expedition

LIKE men in a nightmare of slow motion, leaden-footed, we moved up the steep, snow-filled gully, gasping, fighting for air. I would halt, rest for a minute, stagger upward eight paces or nine, hang upon my ice ax until breath and life and the will to go on returned, then stumble another half-dozen steps to take in rope for Da Namgyal.

Stouthearted as any Sherpa, Da Namgyal was silent but nearly spent. Carrying 45-pound loads, we had topped 27,000 feet, above Everest's South Col, hopeful of placing a camp on the snow shoulder for Hillary and Tenzing to use on the expedition's second and ultimate assault.

Near the Limit of Endurance

Tom Bourdillon and Charles Evans had pressed on ahead of us into the mist, charged with making the first bid for the summit. But I could read in my Sherpa's drawn face and in the tortured laboring of my own lungs that we had nearly reached our limit. I was too dazed to know it at the time, but a blockage in my oxygen set was drastically cutting down my supply of air.

For a few hundred feet more we continued the ascent, passing the tattered skeleton of the last tent the Swiss had pitched here the year before. Then, on a tiny shelf about 27,350 feet, barely large enough to sit on, we stopped. Into a notch on the Southeast Ridge we tucked the supplies we had borne: a tent, food, kerosene, candle, matches, and our own oxygen bottles, and built a tiny cairn to mark the place.

Before we turned back, I looked out through the broken sea of clouds now swirling in against us and found myself wondering, like many an Everester before me, what force could possibly have brought me, cold, exhausted, and bemused from lack of oxygen, to this barren perch on the highest and most inhospitable mountain in the world.

Everest: Always Before Inviolate

A long story, and not merely mine. It involves the fate and fortunes of many gallant mountaineers, and it really begins, I think, not in London nor at Everest's base, but in the far-off, cloud-capped Tibetan city of Lhasa. Here, one winter morning, in the Inner Enclosure of the Jewel Park, the Dalai Lama of Tibet handed the British political agent a precious document. It was only an unsigned strip of paper, but on it Sir Charles Bell could read:

"To the west of the Five Treasuries of Great Snow Mount in the jurisdiction of

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The National Geographic Society here records in its official journal the successful ascent of earth's highest mountain, through the cooperation of the Royal Geographical Society and the Alpine Club of Great Britain and E. P. Dutton & Company and Hodder & Stoughton, respectively publishers of the American and British book editions, *The Conquest of Everest* and *The Ascent of Everest*, by Brigadier Sir John Hunt and Sir Edmund Hillary. *The Picture of Everest* by the same publishers will appear soon.—The Editor.

1 Indian Air Force, Official

The Target: Mount Everest, 29,002 Feet High

Earth's loftiest point, this Himalayan monster for 32 years defied the world's best mountaineers, sent seven major expeditions reeling in defeat, claimed the lives of at least 16 men. On March 10, 1953, a British party led by John Hunt sallied forth to launch yet another attack. This air view looks northward from Nepal into Tibet.

Down Bhadgaon's Cobbled Streets Wind Expedition Bearers, en Route to Everest

Before World War II all climbing parties tackled the mountain's north face, by way of Tibet. Then Red Chinese invaded Tibet and the northern approach was closed. In 1951 a British group explored a route through Nepal, opening up Everest's southwest flank and paving the way for the 1953 assault. Willrid Noyce, rucksack on back, brings up the rear in this suburb of Katmandu, Nepal's capital.

White Glass Fort near Inner Rock Valley monastery is the district called 'The Southern Country where Birds are Kept.'"

First Opened to Climbers in 1920

This note, and the official passport which followed it, signified the first permission—long denied—ever granted Europeans to climb earth's highest peak. The "Five Treasuries" were the five summits of Kanchenjunga; "White Glass Fort" was the hill town of Shekar Dzong; the monastery lay in Rongbuk Valley; and "The Southern Country where Birds are Kept" held the massive eminence called Chomolungma, "Goddess Mother of the World": Mount Everest.

That was December 9, 1920. In the 32 years that followed, seven major expeditions sallied forth to conquer Everest, well equipped, led and manned by mountaineers of superlative caliber, and in most instances supported by small armies of porters. Each party pressed the attack to the uttermost limits of human endurance, threw all its resources, skills, hopes, and even lives into the attempt—and fell back defeated.

Humped Under 60-pound Loads, Porters Wobble Across Brawling Dudh Kosi River

Many a noted Alpine peak can be climbed and descended in a day on little more than a packet of sandwiches and a flask of water. But merely to approach a major Himalayan mountain demands months of planning, testing, and assembling of equipment; mobilization of a brigade of porters; and weeks of trekking through foothills. This expedition shipped tons of supplies from Bombay to Katmandu; from there 450 carriers packed the loads for 17 days to Thyangboche. The march to covered 175 miles. Yet Everest still loomed, icily indifferent, 15 miles away.

✝"Hail, Jewel in the Lotus!" Read Prayers Painted on a Cliff Overlooking Solu Valley

From Katmandu, at 4,200 feet, the expedition's route cut across the Himalayan watershed, surmounting passes higher than the Pyrenees and threading forests bright with 40-foot rhododendrons, pastel-tinted primulas, magnolia flowers of snowy white. Through the trees flashed scarlet minivets, bulbuls, sunbirds, gay flycatchers.

After months of arduous preparations in England and days of dusty travel northward from India, climbers found the march in a glorious vacation. Aware that Everest later might drain several pounds a day from those working above 20,000 feet and force many a sleepless night, men ate with redoubled appetite and cat-napped at every opportunity.

Off at 6 a.m. after a cup of tea, the caravan would halt about 8:30 beside some roaring stream for porridge, eggs, and bacon, and a chance to swim (page 9), rest, read letters, or chase butterflies. Camp would be pitched by early afternoon.

Here George Lowe, on a ledge in Nepal, gazes back toward India.

♠ **Mist-wreathed Khumbila Juts Above a Monastery**

In the topmost apartment the Abbot of Thyangboche served buttered Tibetan tea to members of the expedition and warned them of the Abominable Snowman.

This fabled creature, whose supposed footprints have often been photographed in the high Himalayan icefields, was pictured by the abbot as 2 feet tall and covered with reddish hair. The "Yeti," he said, had once invaded the monastery grounds in winter, only to be driven away by loud blowing of horns and conch shells.

Hunt agreed to keep a lookout for the monster, and the abbot promised to pray each morning for the party's safe return.

Some European climbers believe the Snowman is either a rare type of Himalayan bear or a big langur monkey.

➔ Nepalese porters pad down the track toward Thyangboche. Villagers along the route greeted the caravan with barrels of *chang*, a rice-brewed beer, and gaily decorated pots of tea.

Until May, 1953, Everest, towering 29,002 feet astride the border of Nepal and Tibet, stood inviolate. Seven British climbers, one Sherpa, and a Swiss had struggled up its slopes of ice and rock to within 1,000 feet of the summit. Of this valiant band, two—George Leigh-Mallory and Andrew Irvine—had in 1924 vanished forever into the mists along the Northeast Ridge, ascending no man knows how high before they died (page 15).

Above 20,000 Feet Climbers Deteriorate

What manner of mountain is this which for so many years so easily shrugged off all assaults and claimed the lives of at least 16 men?

Other peaks demand more actual climbing. Alaska's Mount McKinley, for example, measures 19,000 feet from its lowland base, while Everest rises only about 12,000 above the 17,000-foot Tibetan plateau.* Himalayan winds are fierce, but the Scottish Highlands, battered by the North Atlantic's hurricanes, endure gales as terrible. Everest's crags and crevasses test any man's ability, but half a dozen Alpine peaks offer technical problems of greater severity. Everest can chill a man to the marrow with summer temperatures down to —40° F. at night; yet on the Greenland icecap and elsewhere explorers have lived through cold worse by 30 or 40 degrees.

What makes Everest murderous is the fact that its cold, its wind, and its climbing difficulties converge upon the mountaineer at altitudes which have already robbed him of resistance. At 28,000 feet a given volume of air breathed contains only a third as much oxygen as at sea level. On the ground, even if a man were exercising violently, his lungs would need but 50 liters of air per minute. Near Everest's summit he struggles to suck in as much as 200 liters. Since he inhales his air cold and dry and exhales it warm and moist, the stress on his parched lungs and respiratory passages becomes appalling.

Heart and Lungs Adjust to Added Strain

Exposed suddenly to the low atmospheric pressure of Everest's upper ridges, the average climber would slump unconscious within five to ten minutes, and eventually die. Allowed to acclimatize himself for a month or so by repeated forays into the 15,000- to 20,000-foot ranges, the same climber's body will adapt to survive. His bone marrow, which manufactures oxygen-carrying red corpuscles, will raise its sea-level count of some five million red corpuscles per cubic millimeter to about eight million. His heart muscles will adjust to the new strain put upon them. His lungs will become more used to rapid-fire respiration.

Yet for even the best acclimatized mountaineer, and men differ sharply in their ability to acclimatize, Everest offers only slow deterioration. Above 25,000 feet the climber's heavy legs seem riveted to the ground, his pulse races, his vision blurs, his ice ax sags in his hand like a crowbar. To scoop up snow in a pan for melting looms as a monumental undertaking. In the words of a Himalayan veteran, Frank Smythe: "On Everest it is an effort to cook, an effort to talk, an effort to think, almost too much of an effort to live."

If, nevertheless, there were an "open season" upon Everest the year round, some expedition hardier or luckier than the rest would long since have stumbled to the top.

Monsoon and Winter Defend the Summit

The mountain's subtlest defense is the prohibition it places upon climbing it at all except during a few unpredictable days in late spring, between the lulling of the northwest wind's gales and the arrival of the snow-laden monsoon, and for a brief spell in the autumn.

In winter the peak's flanks may lie invitingly bare of snow, but the wind which has scoured them clean is too brutal for mortal men to face. In summer the great snows deposited by the monsoon, lying high above the evaporation line, rarely pack down into dependable slopes; to flounder across such powdery drifts is to invite at the least exhaustion, at worst a fatal slip or the detonation of a suffocating avalanche.

Why, then, do men pit their frail resources against a citadel so well protected? Mallory had his classic answer: "Because it is there." But there is another reason, rooted fast in the sheer, stubborn tenacity of man. Capt. Geoffrey Bruce, of the 6th Gurkha Rifles, stopped in his tracks at 27,235 feet by a technical fault in his oxygen apparatus, was rescued in a critical condition by his companion, George Finch. He paused to shout up at the summit before he turned back: "Just you wait, old thing, you'll be for it soon!"

As for those of us who set forth against

(Continued on page 17)

* See "Mount McKinley Conquered by New Route," by Bradford Washburn, National Geographic Magazine, August, 1953.

Reproduced by Sir Edmund Hillary and Alfred Gregory (below) © R.G.S. and Alpine Club

Nepal's Thatched Villages Wake to the Tramp of Supply Train Porters

The party found most fields still in winter's grip and no shortage of men to act as carriers for 3 rupees (63 cents) a day. A panther prowled about the camp one night, and a fight broke out between bearers armed with *kukris* (hillmen's knives). Otherwise the expedition passed in peace through hamlets like Rising.

In Glacier-fed Dudh Kosi, Hillary Enjoys His Last Bath for Months

Plunging into a similar pool in the Likhu stream the week before, Charles Evans was suddenly pulled under by the fierce current. Before Hunt and Edmund Hillary could dive to his rescue, he bobbed up, was hashed against a rock and sucked down once more. Still conscious, he finally managed to drag himself out.

VIEW FROM WEST

Buildup Phase

Mount Everest 29,002 feet
Five and one-half miles high

Northeast Ridge

Southeast Ridge

South Face

CAMP VIII, 25,800 feet. Pitched May 24 by Hunt, Bourdillon, and Evans, 19 Sherpas reached here, six of them twice, packing 500 pounds of supplies.

Lhotse 27,890 feet

Nuptse 25,680 feet

THE TRAVERSE. First made by Noyce and Annullu, next day Hillary, Tenzing, and Wylie led 14 Sherpas across.

South Col

Geneva Spur

Lhotse Face

CAMP VII, 24,000 feet. Halfway on grueling climb from Camp V to South Col.

Lhotse Glacier

CAMP VI, 23,000 feet. Used briefly during trailmaking on the lower part of Lhotse Face.

Western Cwm

CAMP V, 22,000 feet. Foot of Lhotse Face.

CAMP IV, Advance Base. Here at 21,200 feet as many as 30 men lived in a tent village while supporting the assault parties.

Khumbu Glacier

Stifling heat in the morning, snow every afternoon, and night temperatures as low as minus 10° F.

CAMP III, 20,200 feet. 100 less than McKinley, North America's highest peak was the lower terminal for supplies being packed up the Western Cwm.

Rope Ladder

Nutcracker

Pack trail located in center of ice(a) to avoid avalanches.

CAMP II, 19,400 feet. This rest station for pack teams was abandoned because of alarming glacial movements.

Atom-bomb Area

Lho La (Pass) ½ mile

Hell-fire Alley

Hillary's Horror

Mike's Horror

THE KHUMBU ICEFALL. Gigantic blocks of ice gradually shift downward, 2,000 feet per mile. Three tons of supplies were carried over it to Camp III.

Khumbu Glacier

BASE CAMP, 17,900 feet. Eleven tons of supplies were carried 13 miles from Thyangboche by 450 porters.

Drawn by Irvin E. Alleman

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Tibetans Know Everest's Sky-piercing Eminence as Chomolungma, "Goddess Mother of the World"

Youngest of the world's great ranges, the 1,500-mile Himalayan barrier curves east and west in a protective arc that, through history, has blocked Mongolians and Tibetans from the lush Hindu lands. Two Sanskrit words—*hima* and *alaya*—give this vast uplift an apt name: "The Abode of Snow." From its glaciers stem three of India's holiest rivers: the Ganges, the Indus, the Brahmaputra.

Mallory, gazing over into the Western Cwm on his reconnaissance in 1921, named it after highland glens he had explored in his youth. Cwm, a Welsh term pronounced "coom," is an enclosed valley, usually on a mountain's flank. Col, another oft-used climber's word, means a depression or pass on a mountain chain.

✝ Everest's Fortress Lies Hidden Behind a Massive Rampart

The covered summit peeks over the jagged, snow-clad ridge of Nuptse (opposite), 15 miles from the Thyangboche camp. Lhotse, here feathered with cloud, ranks fourth among the world's peaks, towering 27,890 feet.

←Sherpas, an elite group of carriers, help erect a dome tent. Although comparatively heavy, this 12-man shelter was brought along for extra comfort. Sixty porters once crowded under it during a storm.

→Just as a practice climb, part of the expedition romped up "an attractive little peak" of 19,400 feet and christened it Chukhung. Here climbers, roped for safety, traverse, or move crosswise.

Photographs by George Lowe (above) and Elsie Morton by Alfred Gregory
© N.G.S. and Alpine Club


IX
VIII
IV
III
II
Base
Camp

Route up Everest's Southwest Flank Follows a River of Ice

Everest's massive inner fortress, skirted by a frozen moat, defends itself with three deadly weapons: altitude, weather, and terrain.

Drop a man, unacclimatized and shorn of any oxygen supply, upon this 29,002-foot summit, and he will become unconscious within 10 minutes, gasping for breath in thin, bitter air that contains less than a third as much oxygen as at sea level. Even climbers who have accustomed their bodies to such heights by repeated forays above 20,000 feet cannot long remain there. Soon muscles, nerves, and the mind itself begin sharply to deteriorate.

Bone-chilling as Everest's spring temperatures can be, they would not be so lethal without the wind. On still days tight-woven tents and arctic clothing can keep men warm even at —40° F. But when tent-rattling gusts shriek over the ridges, climbers lose heat and energy rapidly, with frostbite an ever-present menace.

For only a few weeks each year is Everest climbable at all. The winds of winter would stop any expedition dead in its tracks. Summer's monsoon blankets the mountain with drifts apt to slip and smother the most dauntless attack. Only in the brief, undependable interims of late spring and fall does Everest drop its guard a fraction.

Route of Hunt's party ran along Khumbu Glacier, beginning at lower center, around the bend into the Khumbu Icefall, through the high valley of the Western Cwm, up the snow-mantled face of Lhotse, and across to the South Col.

George Leigh-Mallory and Andrew Irvine, struggling along the Northeast Ridge, vanished into the mists at + on their fatal quest of the summit in 1924.

Not till nine years later was the first air view of the peak obtained. Story of this "Aerial Conquest of Everest" was related to National Geographic Society members in the August, 1933 issue of the National Geographic Magazine by Lt. Col. L. V. S. Blacker, O.B.E.

Thumbprints Act as Receipts in Payoff at Thyangboche

An expert skier and climber from boyhood, John Hunt (left) won the Sword of Honor at Sandhurst, England's West Point, and elected a military career. During World War II he commanded the 11th Indian Infantry Brigade in Italy, earning the D.S.O. for gallantry. He was helping to plan Allied maneuvers in Germany in the fall of 1952 when the Joint Himalayan Committee selected him, at the age of 42, to head Britain's first major postwar Everest expedition.

Michael Westmacott shows a porter where to place his "signature" on the expedition's ledger as Hunt counts off wages in Nepalese notes and silver rupees. Released at the monastery, most of the expedition's porters returned to Katmandu.

Tenzing Tests His New Crampons; Lowe Looks On

No other climber has done battle with Everest more often than Sirdar Tenzing Norkey, the wiry, resolute, 39-year-old Sherpa.

Tenzing, born in Nepal and raised in India, encountered Everest first in 1935 as a young porter. When he arrived to join the Hunt party for his sixth march to the mountain, he was still recovering from a 1952 climb that stopped only 1,000 feet short of the summit.

George Lowe, New Zealand schoolteacher and an accomplished ice climber, won his place in the party by his fine showing in the attempt on Cho Oyu, an Everest neighbor, in 1952.

Everest in 1953, I think we shared a sense both of high adventure and of fellowship with all those who had done battle with this mountain before and who had passed on to us, with open hands, the heritage of their experience. It was not glory we sought, unless it be the common glory of man's triumph over Nature —and over his own limitations. Mallory, again, spoke the final word on the conquest of mountains: "Have we vanquished an enemy? None but ourselves."

The telegram inviting me to lead the British expedition to Everest reached me on September 14, 1952, when I was deeply enmeshed in plans for Allied military maneuvers in Germany. Nearly a month elapsed before I could extricate myself and report in London to the Joint Himalayan Committee of the Alpine Club and the Royal Geographical Society.

This committee, formed in 1919, had sent out all previous British expeditions to Everest, including Eric Shipton's reconnaissance group in 1951 and a training team to Cho Oyu the next year. It had raised funds, obtained political sanction for the expeditions, obtained scientific help on a large scale from the Medical Research Council, the Royal Society, and other bodies, and set in motion many other projects.

Iron Curtain Closes Tibetan Approach

Our plan, in its main outlines, was clear. The northern approaches to Everest via Tibet, used by all previous British attempts at the summit, were now closed to us by the Iron Curtain of the East. Nepal, however, ending its long ban on European entry, had in 1949 opened up to us the little-known southern aspect of the mountain (map, page 11).

This side had never been considered promising. It condemns the intruder to climbing up the long Khumbu Glacier, surmounting its fantastic 2,000-foot, crevasse-riven icefall, traversing the abrupt ice slopes of Lhotse to Everest's South Col, and only then—still 3,200 feet below the summit—beginning the final assault. Mallory, having gazed upon this frozen cataract from the north in 1921, described it as "one of the most awful and utterly forbidding scenes ever observed by man" and called it quite unclimbable.

But Shipton and his men had hacked their way to the top of the icefall in 1951. The Swiss team had penetrated it again in 1952, emerged in that strange freak of Nature, the hidden valley called the Western Cwm, cut a route to the South Col, and very nearly achieved the summit itself.

We were convinced that, in mountaineer's jargon, the Nepalese approach "would go." Accordingly, in the crowded winter weeks before our departure for India, we set about the selection and equipping of our party with as much confidence as any Everest expedition can muster.

Choosing Men to Match the Mountain

My first concern was men. I was looking for climbers between 25 and 40 years of age who combined stamina, Himalayan experience, and a quite unusual endowment of selflessness and patience. From an embarrassing wealth of applicants, I chose finally these companions:

Charles Evans, an imperturbable 33-year-old surgeon who had gone to Annapurna with the Tilman team in 1950 and to Cho Oyu with Shipton in 1952; Tom Bourdillon, a hefty physicist of 28 who had already made a dazzling record as an Alpinist before he tackled the Himalayas; Alfred Gregory, 39, the thin but wiry director of a Blackpool travel agency, who had proved on Cho Oyu his ability to acclimatize, despite his years.

Other members included Charles Wylie from the Brigade of Gurkhas, a 32-year-old officer who had survived three years in a Japanese prison camp and had climbed widely in the Alps and in Garhwal; Michael Westmacott, 27, an ex-president of the Oxford University Mountaineering Club; George Band, mature beyond his 23 years, who at Cambridge had also been president of his university's climbing club; and Wilfrid Noyce, 34-year-old schoolmaster, author, Alpinist, and wartime instructor for the Royal Air Force in mountain craft in Kashmir.

Michael Ward, 27, would be our doctor and a reserve climber we could count on (it was he who had first suggested the 1951 reconnaissance of Everest's south flank).

Hillary Had Impressive Record

Last, but obviously not least, were our New Zealand members: Edmund Hillary, the lanky, dynamic, 33-year-old beekeeper from Auckland who had so impressed his fellow climbers on the 1951 and '52 trips into the Himalayas; and George Lowe, 28, a schoolteacher from Hastings with a great reputation for ice technique (page 33).

To this group we eventually added four

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On Thyangboche's Sunlit Meadow, 13,500 Feet High, Climbers Sort Their Supplies

Ropes of a rough corral keep overcurious folk of the monastery at a distance. George Band (foreground) opens boxes holding wireless equipment. Beyond him Tom Bourdillon sadly checks oxygen bottles; a third, he discovered, had gone flat. Sherpas camp in tents at left; British use bedrolls around the domed mess tent.

Kodachrome by Sir Edmund Hillary © R.G.S. and Alpine Club

The Expedition Pitches Rear Camp in a Buddhist Wildlife Sanctuary

Protected by the monks of Thyangboche, musk deer, monal pheasant, and Himalayan partridges wandered at will near these tents. When climbers bought a lamb for dinner, George Lowe had to butcher it himself. Round, kilnlike chorten in background, surmounted by spire, holds revered remains of a holy abbot.

others: Griffith Pugh, expert in high-altitude physiology and a crack skier; Tom Stobart, a cameraman who had accompanied other expeditions to the Antarctic, Africa, and the Himalayas; James Morris, representing the London *Times*; and—when we met him later in Katmandu—Sirdar Tenzing Norkey (page 10), the intrepid Sherpa who had gone to about 28,000 feet the spring before with the great Swiss guide, Raymond Lambert.

Oxygen Sets—Closed Circuits vs. Open

Second only in importance to the quality of our men would be that of our equipment—especially our oxygen sets. Many mountaineers contend that Everest can be climbed without such breathing apparatuses. Perhaps it can. Certainly Norton in 1924, and Wager, Harris, and Smythe in 1933, struggled to more than 28,000 feet on their own lung power and felt they could have gone higher if they had had more hours of daylight left and a greater reserve of strength. But the problem of Everest lies just there—in getting high enough fast enough, meanwhile conserving the energy necessary to make the final effort.

The mountain, we felt, would be sufficiently lethal, with or without the use of oxygen, to satisfy the sporting instincts of the most demanding. Our greater concern was whether we could devise oxygen sets that would be truly efficient. Earlier models, weighing more than 40 pounds, had cost climbers as much in the fatigue of carrying them as they had contributed in easier breathing.

We settled finally upon two types. The first, upon which we were mainly to rely, operated on the open-circuit principle: bottles on the climber's back feed oxygen to his face mask, where it is mixed with outside air, breathed, exhaled, and lost.

Using the closed-circuit system, the climber inhales 100-percent oxygen from a breathing bag. Exhaled, his breath returns to the bag through a soda-lime canister, which removes the carbon dioxide. The obvious advantage of this mechanism is that it can make a given supply of oxygen last much longer, but the set is heavy, its breathing valves tend to freeze when new canisters are inserted, these canisters are easily damaged, and, at low altitudes, the whole apparatus generates far too much heat.

Both sets, even after our harassed technicians had shaved over them, still weighed more than I cared to contemplate. With two cylinders of oxygen, the open-circuit model weighed 28½ pounds; the closed-circuit type with one bottle and one canister, giving about the same number of hours' supply of oxygen, weighed 35 pounds.

For our tents we adopted a new cotton-nylon weave. As wind-tunnel tests proved, this light, tough fabric could withstand gales up to 100 miles per hour.

Nylon-covered sleeping bags had both inner and outer bags of down, yet weighed only about nine pounds.

Special aluminum jackets attached to our primus and butane-gas cookers promised to shield them from gusts that can blow out the flame and to conserve their heat—a very important function at high, dry altitudes where men get so parched but snow takes so long to melt on the stove.

Footwear was a problem in itself. In the Himalayas the slightest moisture from perspiration or from snow causes ordinary mountaineering boots to freeze as if they had been cast in bronze. All too well we could remember Maurice Herzog and the agony he suffered from frostbitten, gangrenous feet after his ascent of Annapurna in 1950.

So we designed two types of boots. The first were light and close fitting for tricky climbing on the icefall and in the Western Cwm. The special boots for high-altitude climbing contained an insulating filler of kapok between a layer of thin glacé kid with an outer waterproof cover and an inner waterproof lining; soles were made of airy, microcellular rubber. Weight of this heavier pair: about 4 pounds, 4 ounces (page 33).

Climbers Choose Their Favorite Foods

Food and drink. . . . Here we hoped to strike a middle course between some earlier expeditions, which had offered truffled quail and champagne, and the ascetic Maurice Wilson, who in 1934 decided to tackle Everest alone on a few handfuls of rice—and died in the attempt.

At very high altitudes men look with profound loathing upon food they would have devoured with relish at base camp, and their consumption of liquids goes up to 5 and more pints a day. In each vacuum-packed beverage box we supplied enough powdered milk, tea, coffee, and cocoa to quench the thirst of 28 men for one day.

We had each of our climbers select the

(Continued on page 29)

↑ Settled at Camp I, Climbers Plan Siege over Mugs of Tea

Day after day, supply parties set out from this base to thread the jumbled, crevasse-scarred icefall and establish a forward dump at Camp IV, high in the Western Cwm.

It took nearly a month of grueling, dangerous porterage to lift three tons up this treacherous 5-mile route. Afternoon snowfalls wiped out tracks cut in the morning. Overnight shifts in the glacier stranded trail flags and spilled bridge poles into widened ice fissures.

Brain Surgeon Evans → Turns Barber

Skilled enough with a scalpel, Evans took lessons in haircutting before leaving London. Climbers wearing the closed-circuit type of mask, which fed its wearer pure oxygen, needed to be fairly clean-shaven for an airtight fit. Open-circuit users like Lowe (right), who breathed a combination of oxygen and outside air, could indulge in a beard.

Photographs by Alfred Gregory
© B.B.C. and Alpine Club

Ektachrome by Alfred Gregory © R.G.S. and Alpine Club

Never Silent, Never Still, Icefall's Frozen Cataract Raises a Grim Obstacle Course

When George Leigh-Mallory, Everest's great adversary, glimpsed this rumbling, restless mass in 1921, he called it "one of the most awful and utterly forbidding scenes ever observed by man." Here members of the 1953 expedition start up to hack a route that later supply ferries can follow.

Sherpa Da Namgyal Has His Oxygen Mask Fitted by Dr. Evans

A Fellow of the Royal College of Surgeons, Charles Evans has squeezed enough time between professional duties to climb widely in the Alps and Himalayas. At 30 he attacked the Annapurna range; two years later, in 1952, he joined Eric Shipton in the attempt on 26,867-foot Cho Oyu.

Da Namgyal, an Everest veteran, was hit by falling ice on Lhotse Face when portering for the Swiss in their attempt in the autumn of 1952. The same avalanche killed his companion, Mingma Dorji, who lies buried on the mountain's flank.

The notion of breathing "English air" amused the Sherpas at first. Later they discovered oxygen's virtues at high altitudes.

Pine Pole Will Span a Crevasse

Sherpas fasten a rope and stake to steady this slender bridge and mark where it falls if the fissure's lips suddenly yawn. Though tumbles into these icefall crevasses occurred often, quick work on the climbing ropes prevented fatalities.

Photographs by Alfred Gregory
© R.G.S. and Alpine Club

Ice Haystack, Menacing Camp II, Obligingly Remained Upright During Assault

Climbers dozing in these tents halfway up the icefall would stir uneasily as shelves of the glacier ahead collapsed with a dull "wumph" and avalanches plunged down the cliffs, roaring like subway trains. Cracks even appeared in the ice under the tents one night—after which Sherpas bringing loads up from Base Camp preferred to skip this way station and push on to Camp III.

No ice pinnacles such as this fell on the party, but several crashed across the track only a few minutes after supply ferries had passed.

Amateur strategists in London had suggested various devices for getting supplies up Everest with less effort. One was to lay an air hose up the cwm, with occasional spigots at which climbers could imbibe pure oxygen. Another called for firing oxygen bottles ahead by means of large mortars. A third would have had the climbers supported by individual balloons, their feet lightly brushing the snow. In the end, Hunt's men found no substitute for slogging up the mountain with packs on their backs.

➔ Ready to tackle the foot of the icefall, about 20 minutes' climb from Base Camp, Sherpas strap on their crampons, the spiked climbing irons that mountaineers use for better traction on ice (page 16). Aluminum pack frames are British Army type, weigh less than a pound. Sherpas on this low-level ferry usually carried 45 pounds.

Above: Fixed rope ladder leads up a 35-foot ice cliff to Camp III, at the top of the icefall. Without this staircase, Sherpas would have been forced to wedge their way up the dangerous ice crack at right, only other route to the plateau above.

↑ Camp III: Climbers Approach Height of Mt. McKinley

Snow arch below cliffs of Nuptse's ridge may topple soon, but not on tents; 50 yards and a deep chasm intervene.

Hillary led many of the ferries up from Camp III at 20,200 feet to Camp IV (page 37). This 1,000-foot trip took less than three hours in good weather, five or more when drifts obliterated the track.

Outside the pyramid tent Hillary checks his camera as Sherpas load up for the day's trek. Red, black, and yellow flags will mark changes in route.

← Ice of Western Cwm Ascends in Giant Steps

Notebook in hand, Wilfrid Noyce takes a quick inventory of his team's load just above Camp III. Their zig-zag route will take them far to the right, then across the defile above the ice steps to a sheltered hollow around the corner of Everest's flank at left.

At the head of the cwm, rumpled masses of ice cascade down the west face of Lhotse, key to the ascent of Everest's South Col (page 39).

Kodachrome by Alfred Gregory © N.G.S. and Alpine Club

particular items he felt sure he would like to eat even at 25,000 feet, and these we packed in "luxury boxes." Our notion was that assault parties could then discard some of their standard rations before a big climb and substitute delicacies of their own choice.

In the little time we could salvage from these quartermaster operations, we indulged ourselves in some practice climbs in Wales and in the Alps, partly to test our new equipment and rations, partly to let our new team get to know one another "on the rope," and partly, of course, to stretch our muscles and clear the fog of London from our lungs.

Dress Rehearsal in the Alps

For four days, in fact, some of us camped at 11,340 feet on the crest of the Jungfraujoch, trying out various boots, tents, sleeping bags, stoves, clothes, and meals, while the thermometer skidded to —4° F. and a blizzard whipped snow off the peaks and flung it at us like birdshot.

After this boisterous reception—a faint foretaste of what awaited us in the Himalayas—it was with mixed feelings that I read a telegram telling me of the Swiss expedition's decision to withdraw from Everest after two gallant attempts. It was our turn now. Where climbers as brilliant as Chevalley and Lambert had failed, could we succeed? We had reason to wonder.

Three months later we assembled in Katmandu, capital city of Nepal. The intervening weeks had been filled with more last-minute crises, midnight conferences, interviews, lectures, television and radio appearances, inventories, and travel arrangements than I have either time or temper to relate.

Most of our party went out to India by ship; a few like myself, delayed by business or illness, flew. All of us, I think, were equally relieved when, on March 10 and 11, our porters (weighed down by the tons of supplies we had brought up by rail, truck, and overhead ropeway) filed out across the green and tidy Valley of Nepal for the long trek to Thyangboche, our first Base Camp.

Our route cut squarely across the Himalayan watershed, plunging us into deep valleys, carrying us over foaming torrents and swift-flowing rivers and up the far hillsides (pages 5, 6, 7, and 9). This was big country, warm and welcoming.* Along the track we passed Nepalese girls ajingle with earrings, glass bangles, and necklaces of crimson beads. Their wide-grinning men were close-cropped and scantily attired. On the ridges we trod a carpet of mauve primulas, and in the forests the heavy-scented white magnolia blossoms lay like fallen snow.

Flickering in and out above the gnarled, full-flowered rhododendrons darted gay sunbirds, flycatchers, scarlet minivets, green-backed and redheaded titmice. Up on the steep slopes, laboriously terraced, hayricks planted in the branches of trees drew our astonished glances.

These were enchanted days, bright with the promise of adventure and free from the exasperation of the winter's paperwork. We ate heartily and with what Everester Bill Tilman used to call "dogged greed." For on the topmost heights far ahead of us we could each anticipate a rapid loss of weight.

Sixth Everest Expedition for Tenzing

As we strolled along, I was able at my leisure to become better acquainted with our Sherpas—and especially with their renowned leader, Tenzing Norkey. Lighthearted, simple in manner, but with an evident authority, Tenzing impressed me at once.

Few men had seen more of the world's highest mountain. Ours was the sixth Everest expedition he had joined; the first had been in 1935 when he served as a 21-year-old porter. His great exploit of reaching the Southeast Ridge in 1952 with Lambert had, we feared, undermined his health, and he himself had written me that he could probably serve only as far as the icefall. Yet now, to my delight, he seemed not only fit but frisky.

His fellow Sherpas from Darjeeling were a colorful lot, clad in green berets, blue skiing caps, balaclavas, vivid sweaters, and rather large boots. Thondup, the cook, was there;

* See "Peerless Nepal—A Naturalist's Paradise," by S. Dillon Ripley, National Geographic Magazine, January, 1950.

← **Porters Give Snow-lipped Crevasse a Wide Berth**

John Hunt, leading a reconnaissance team up the Western Cwm, found this route blocked by a long 60-foot-deep crack, too wide to span with poles or aluminum ladder. Anxiously he skirted its edge, aware that if he found no way across, a dangerous traverse under the avalanche-triggered cliffs of Nuptse ahead would be necessary. Luckily, just short of the mountain's foot, he discovered a snow bridge solid enough to support a climber's weight.

30

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Icy Tombs Lurk for Those Who Lack Good Balance, a Solid Belay, Strong Nerves

A Sherpa stands ready to anchor the rope around his ax shaft if his companion should tumble into this crack near Camp II. Till European climbers came to the Himalayas, Sherpas had shown no interest in ascending their awesome mountains. But, once caught up in the enterprise, they proved tough and game. Said Hunt: "Their cooperation in the essential teamwork of the whole party, their own individual performances, are beyond praise."

Sherpas Demonstrate Proper Technique in Crossing a 2-pole Bridge

During the early days of the Icefall lift, one young cook's helper tried to negotiate a span like this, turned rigid with fright halfway across, and plummeted into the crevasse. Hauled out "like a dead seal" by Evans, he returned sadly to kitchen duties. As veteran Everester H. W. Tilman once said: "We live and learn, and big mountains are stern teachers."

Kerken with his prizefighter's face; wizened, pig-tailed Da Tensing; jaunty Annullu, solemn Ang Namgyal, my companion on the South Col, Da Namgyal; husky, jocular Pasang Phutar II; little Gompu; and a score of others—good men all (page 40).

Fifteen days out of Katmandu we climbed the last ridge overlooking the village of Namche Bazar. There ahead of us, overwhelming the horizon, loomed suddenly the solid mass of Everest, its peak swept almost bare of snow. Mallory, seeing it for the first time from the north, had called it "a prodigious white fang excrescent from the jaw of the world." Wind-whipped, the fang was now black. But it was no less awesome.

From Namche Bazar we climbed with ever-increasing exhilaration to the monastery of Thyangboche—surely the most magnificent grandstand ever provided for mountain scenery (page 7).

Here, on a grassy 13,500-foot alp where yaks grazed, we pitched camp (page 18). We had much to do; yet again and again we looked up from our tasks, transfixed by the majesty, the sheer icy splendor of the peaks that rose around us: the Everest group; Ama Dablam, whose cruel summit makes the Matterhorn look tame; the twin spires of Kangtega and Thamserku, delicately fluted; Kwangde's long and lofty barrier.

Abbot Tells of Abominable Snowman

Paying off most of our carriers we sorted out our kits, issued mountain gear to the Sherpas, and called upon the local abbot, who entertained us with an account of an Abominable Snowman—five feet high and covered with reddish hair—which had wandered across the monastery grounds a few years before and been driven off by loud blowing of horns and conch shells. I promised to keep a sharp lookout for one of these "Yetis," as the Tibetans call them, as we proceeded to Everest.

Our more serious business in Thyangboche was a three-weeks' period of acclimatization and practice with our oxygen sets. Up beside the Nuptse Glacier, on the Mera La, and in the Chola Valley we set up small camps from which, in high spirits, we surmounted without mishap a goodly number of 19,000- and 20,000-foot peaks (page 13). Tenzing and Wylie trained an elite group of the Sherpas in oxygen use, while Tom Bourdillon and I gave lessons in ice work among the séracs (pinnacles) of near-by glaciers.

Up the Growling, Shifting Icefall

By April 13 we were ready for our first reconnaissance of the Khumbu Icefall (page 22). Up through the *wild*, lunar landscape of the great glacier went a 50-man party of Sherpas, coolies, and climbers, led by Ed Hillary, to establish a camp close to the Lho La (pass). Though plagued by sickness and the onset of snowfalls each afternoon, they managed in three grim days to hack out an incredible route past rickety ice towers, over gaping blue crevasses, and up sheer glazed pitches halfway to the gate of the Western Cwm itself.

The names we gave the more appalling passages along this course suggest some of their charms: "Mike's Horror," a roped staircase hung by Michael Westmacott up the side of a chasm; "Hillary's Horror," a series of steps and handholds which Ed had cut above an aching void; "Hell-fire Alley," a section of shattered and still-shifting ice blocks; "Atom-bomb Area," where with a dull "wumph" ice bridges we had used during the day would collapse overnight.

James Morris described the icefall vividly when he said it was "like a squashed meringue, only, of course, rather bigger, and men are just inserts in it, very small insects, lost in the cream and the crumble." Climbing it, he said, was "like going up the kitchen stairs for three or four miles at a go, three steps at a time and carrying the baby."

Every trip offered a dozen opportunities to take a tumble into a crevasse (pages 30 and 31). Some of our Sherpas, indeed, became quite adept at discovering hidden chasms the hard way. Tubby little Topkie had a particular genius for sudden disappearances through the snow.

Pushing on through the upper reaches of the icefall, via an unpleasant rumbling alley called "The Nutcracker," we came out upon the comparatively open plateau of the cwm and settled upon a site for Camp III (page 26). The icefall route, we decided, would never be a popular and attractive boulevard; in fact, daily snowstorms, avalanches, and upheavals of the glacier would constantly alter its pattern and expose new perils. But basically it was negotiable.

Accordingly, on the evening of April 22, as we munched our supper in the big mess tent at Base Camp, I outlined the stock-piling plan on which our hopes of putting two men on Everest's summit wholly depended.

Stripped to its essence, this plan called for transporting three tons of supplies via Camp III at the top of the icefall to our advance base at Camp IV, high up in the cwm. From here would begin the crucial carry past Camp V, up Lhotse's glacier to Camps VI and VII, and the long traverse across the face to Camp VIII on the South Col—an altitude of 25,500 feet.

The Buildup Begins

In the grueling weeks that followed, a wandering Yeti, or Abominable Snowman, perched invisibly on one of Everest's crags, would have seen a kind of logistical Jacob's Ladder in action, with angelic Sherpas and British climbers toiling endlessly up and down the mountain, passing and repassing each other and getting—so it would seem—nowhere. But little by little the loads went up (page 37).

Sun temperatures of 156° F. baked both cwm and icefall in the mornings, drugging even the keenest with "glacier lassitude." In the afternoons, snow would wipe out the day's track and leave drifts for men to flounder in up to their waists. At night, cold of −2° F. would grip the camps, and our sleep would be punctuated by the roar of ice breaking loose from the cliffs of the Lho La.

Rough work. But not humorless. Michael Ward helped see to that. Dubbed the "Witch Doctor," he was tireless in dispensing his two pet prescriptions. First, "You'll feel better when you get lower down"; and second, "Here, try these; they're no good."

The first reconnaissance team we sent up to Camp IV traveled in relative luxury (that is, without packs) and was promptly christened the "White Elephant Party." Thereafter, whenever another pioneering group set out, Ward would send it on its way with a howl of laughter and the cry: "Well, there

Lowe's Broadcast to Base Amuses Hillary

Five-pound walkie-talkie sets, capable of spanning two miles, aided supply-lift operations. To keep dry-cell batteries warm and in working order, climbers wore them in vests under their clothing.

Climbers kept their goggles always handy. Glare from Everest's icy uplands can quickly cripple men with snow blindness.

Hillary's sister made his striped sun helmet from a child's playsuit.

➔ High-altitude boots were especially designed for the expedition: inch thick insulation of kapok flies under kid leather; soles of sponge rubber; outer covering of waterproof rubberized fabric. Despite this construction, Hillary's boots once froze like iron overnight and took an hour to thaw on the primus stove.

Hunt Serves as Guinea Pig for Physiologist Pugh at 21,200 Feet

By repeated forays above 20,000 feet, a mountaineer can gradually acclimatize himself to some of altitude's strains. The number of oxygen-carrying red corpuscles in his blood increases markedly. He breathes faster to offset the air's thinness. His heart muscles adjust to harder work. Yet, if he remains at great heights, this acclimatization will only mask a remorseless deterioration of nerve and muscle. Appetite declines, weight falls, performance is cut in half, and a deadly lassitude ensues.

Here Dr. Griffith Pugh acts John Hunt to push aside his oxygen mask and breathe deeply into this rubber hose. Chemicals in the glass containers will then measure the percentage of carbon dioxide. The less of this gas the breath contains, the better Hunt's acclimatization.

goes another White Elephant, trumpeting up the Western Cwm!"

The carrier operations of the high-level teams were spectacular in themselves. As one by one his companions were forced down by sickness, George Lowe, in an astonishing display of endurance, spent 11 days above 23,000 feet directing the construction of a route up the Lhotse Face (page 38). Despite blizzards, cold, the insidious effects of altitude, and a wild west wind, Lowe (joined at different stages by Ang Nyima, Michael Ward, and Wilfrid Noyce) pushed a track almost to the start of the traverse.

His achievement readied us for the crucial lift to the South Col. By May 18 we had completed the last low-level carry to Camp IV, which now became our new advance base. Three days later Noyce and Annullu pioneered the traverse in brilliant fashion, right over the Geneva Spur to the col itself.

Forging the Last Link to the Col

Next morning, at 8:30, we watched from the cwm as Hillary, Tenzing, Wylie, and 14 Sherpas—dots on the dazzling face of Lhotse—moved slowly out from behind the ice pinnacle that sheltered Camp VII and began their painful, almost imperceptible ascent.

A long day. Most of them had managed to snatch only a mug of tea and some cereal before starting out, and when they had dumped their vital stores at the South Col, they had still before them the race back down

the traverse. The last straggler stumbled into Camp VII at dusk—10½ hours after they had left it.

Next problem: to bring up the two assault parties, in tandem. As we had determined weeks before, Bourdillon and Evans would lead off, equipped with the closed-circuit oxygen sets they had experimented with so long (page 42). Hillary and Tenzing—who had proved a very strong pair of climbers—would comprise the second wave of attack, using the open-circuit gear (page 44). Each assault party would be backed up by a close-support team.

On the morning of May 24 I went up to the South Col with team one, plus Da Namgyal and Balu. I shall not quickly forget our first camp there. It was late when we topped the Geneva Spur and clambered down onto the desolate col, a wide, wind-scourged ridge of stones encased in bluish ice (page 47). I had exhausted my oxygen, and Evans removed his set, too, to help put up our tent.

Pathetically feeble, we lunged about in a ludicrous tug of war with the gale. Down below we could have erected the tent in two minutes. Here it took us an hour. The wind snatched the canvas from our hands, flailed us with guy ropes, sent us reeling around like drunkards. Once I tripped over a boulder, fell on my face, and lay there for five minutes before I could summon the strength to get up.

Enduring a Day's Rest at 25,800 Feet

I am not sure we would ever have got the tent up if Balu had not stumbled into camp at that time and burrowed into the canvas. He at least anchored it until we could weight the edges down with rocks and oxygen bottles.

Too tired, too muddled for a real assault, we spent the next day sorting our food, preparing the oxygen sets, resting. To let Evans and Bourdillon have the pyramid tent in peace, I pitched our small "blister" tent near by and settled down for the afternoon with George Borrow's book *Wild Wales*. I felt relaxed, disinclined to do anything at all—the danger signal of deterioration.

Trying to fend off the more lugubrious thoughts that can assail one at these altitudes, I turned my mind to others who had camped high on this mountain and learned to laugh at their discomforts. To Mallory in 1922, who had opened his copy of *Hamlet* at random and read with feeling the lines, "Angels and ministers of grace defend us!" To Norton, who had tucked a thermos flask of tea into his sleeping bag at 26,800 feet—only to have the cork pop out during the night. To Bruce in his tent on the North Col, fearful that he was losing his leg, since he could no longer feel it or move it, largely, as he soon discovered, because his companion, Finch, was sitting on it.

Morning found most of us reasonably refreshed from four hours' use of oxygen during the night; only Balu, clearly done in, was unfit to go higher.

Roping up, Da Namgyal and I moved off a little after 7, leaving Bourdillon and Evans frantically working over a broken supply valve in Charles's oxygen set. Within another half hour, fortunately, they had completed repairs and begun their ascent, overtaking us as we rested near the foot of the first couloir.

Supplies Cached on Tiny Shelf

They pressed on, climbing strongly. And we, hunched under our packs, commenced that slow, bone-weary struggle up the steepening gully which was to bring us, hours later, to the tiny shelf where at last we cached our loads. It had taken me, you might say, nine months to get this high—nine months since the day that telegram had summoned me from Germany—and I was to go no higher.

But somewhere up above us, out of sight now, we knew Bourdillon and Evans were making their great bid for the South Peak and, if feasible, the summit itself. Our hearts and hopes went with them. There was scant point, however, in our clinging to our grim eyrie till they should return. With snow flaking down upon our empty oxygen frames, we went down the ridge again, slowly, wobbling, sometimes (for all our caution) slipping.

From the upper slopes we could see small figures traversing from the Lhotse Face: Hillary and Tenzing, supported by Gregory Lowe, and eight Sherpas—the second assault team moving up (page 49). By the time we had descended onto the col, they had arrived and came to meet us.

We must have been an odd sight. Every ten paces or so we had to sit down and rest. At the end, our knees buckled, and we collapsed altogether upon the ice. Tenzing plied us with lemonade from his flask, while Ed hurried off to fetch his oxygen set. Gasping down a strong intake of 6 liters a minute, I was able to lurch the few remaining yards

to our tent. It felt rather good to lie down.

After passing us at the foot of the snow gully, Bourdillon and Evans had made excellent progress up to about 9 a.m., climbing almost 1,000 feet an hour—a rate which would have taken them to the summit with time to spare. But in the next two hours they had risen barely 700 feet; fresh snow covered the rock ledges and gave little grip for their crampons.

On the 28,000-foot snow shoulder, three-fourths of the way up the South Peak, they ran into another problem; the soda-lime canisters in their oxygen sets had only another hour's life. To let them run out before replacement would give the sets a maximum duration. But the expiration of that extra hour might find the climbers in a spot too dangerous to permit fiddling about with canisters. Besides, inserting fresh, cold canisters sometimes froze the valves and this, with the closed-circuit set, would have spelled disaster. It would be better to face such a possibility now. They changed canisters.

Higher Than Any Climbers Before

A traverse across unstable, lightly crusted snow brought them to rock ledges bordering Everest's south face. After the change of canisters, Charles's breathing had become much more rapid. It seems likely now that rifts in the soda lime were allowing the air to race through the canister unpurified, with a resultant accumulation of carbon dioxide in his mask. Climbing very slowly, the two men worked from one handhold to the next up the last few hundred feet. Suddenly they found themselves standing upon the South Peak (page 55).

They had reached 28,700 feet, a mountaineering record. Moreover, they were privileged to gaze across at the final crest and assess the approach no other climber had ever laid eyes on. They were not too delighted at what they saw. End on, the knife-edged ridge seemed to soar upward at a sharp angle. Left, it fell away to rocks dropping sheer to the cwm, 8,000 feet below. Right, an even steeper precipice falling more than 10,000 feet into Tibet was overhung with huge and treacherous cornices of snow (page 60).

To go on? Out of the question. It was now 1:20 p.m. Evans reckoned it would take three hours to the summit, another two back to the peak on which they stood. That would make it 6 p.m., with nearly 3,000 feet still to descend to safety. Their oxygen would last only a fraction of that time.

They turned back—and nearly met disaster on the way down. Bone-tired, they took two and a half hours to reach the top of the 1,300-foot couloir above the South Col, slipping on passages that would normally have given them no trouble at all.

Tom led the way down the gully. He had scarcely reached the rope's end and belayed it around his ice ax when Charles tumbled past him, whizzing down the glassy surface. The rope snapped taut, ripped the ax loose, and sent Tom tobogganing after Charles.

The belay had held just long enough to slow Evans's slide, however, and Tom, instinctively rolling over onto his stomach, dug the pick of his ax into the snow, gently at first, so that it would not be torn from his hands, then more deeply. He and Charles braked to a stop a few yards farther down. They rested a bit, recovered their stance, and started down again.

At about 4:30 we went out to meet them. Their faces rimmed with frost, their backs bent under their packs, they lumbered down the last slopes like men in a weary trance (pages 47 and 50). As Charles said afterwards: "We were too dulled to feel any disappointment. That came later."

But they had not failed. They had achieved the South Peak, studied the final ridge, cached oxygen bottles, and returned to give the next pair the incalculable benefit of their experience and of their confidence that the true crest could yet be ours. They had picked up the baton given them by those who had pioneered the icefall, pressed through the cwm, broken a route across Lhotse's face, and carried to the South Col; and they had taken it higher than men had ever climbed before.

Now they handed over the expedition's hopes to Hillary and to Tenzing.

Day by Weary Day, Laden Ferries Bring Up Supplies for Assault on Everest's Inner Keep

Above: Hillary leads Sherpas up the icefall's last stretch to Camp III. British and New Zealand climbers usually carried a pack on these ferries only if some porter broke down on the trail. But they had to pioneer new routes after every storm, cut steps, fix pitons (spikes) and ropes, and—if possible—conserve some energy for the bit climbs still ahead.

Below: Novce keeps a taut rope on a Sherpa crawling over an 18-foot aluminum ladder. Bunched trail flags stand by his side.

Reconstructions by George Lees (above) and Alfred Gregory © N.G.S. and Wilbur Chun

Lowe, Hero of the Lhotse Face, Looks Down on the Cwm from 25,000 Feet

For 11 days George Lowe, assisted intermittently by Michael Ward, Wilfrid Noyce, and Ang Nyima, fought to hack a path up the knee, treacherous snow of the Lhotse Face. From high on the face a traverse might be made to Everest's South Col, jump-off place for an attack on the summit. Living and struggling above 23,000 feet for as long as any mountaineer in history, Lowe combated piercing cold, blizzards that obliterated all the previous day's painful trailmaking, sickness that depleted his work party, and the fearful deterioration wrought by altitude itself.

Neither Lowe's high spirits nor his appetite, long legendary, waned at these heights. But he found sleeping difficult. Joined by Noyce one night, he took sleeping pills. Barely wakened by the next noon, he reeled along the trail and, during a pause for food, dozed off with half a sardine hanging out his mouth.

Ang Nyima, Lowe's Sherpa companion for the first five days of the work, had not greatly impressed the party at lower altitudes. But on the face he performed like a veteran climber, stamping out a track, cutting steps, fixing hand lines, and keeping his huge, cheerful grin to the last. Later, he was to carry a load higher on Everest than any other Sherpa but Tenzing himself.

© R.G.S. and Alpine Club

Reconstruction by George Band

† Up Lhotse's Icy Face, Gilded by the Setting Sun, Climbers Carved a Zigzag Trail

A silvered ping-pong-ball moon glints above Everest's battlefield. There Hunt's party profited by the mistakes of earlier teams. A Swiss group in 1952 tried to rush Everest by striking directly up the barren rocky rib immediately to the left of Lhotse's great snow slopes. They arrived so exhausted that their attack on the summit failed. The 1953 British expedition chose instead to use a series of switchbacks up this steep slope, a more roundabout but less dangerous and taxing route (page 49).

† High on Lhotse, with his hand gripping a guideline, Noyce keeps close watch on a tricky spot while traversing to the South Col.

Reconstruction by George Lees

← Ice Ax Ready, Tenzing Crampons down an Icy Pitch

A strong, tireless climber, Tenzing learned his rope and ax techniques on European expeditions into the Himalayas. Now, as chief instructor of a school in Darjeeling sponsored by the Indian Government, Tenzing is tutoring other young hillmen in mountaineering arts.

Even from Lhotse → Everest Masks Its Secret Summit

Wisp of blown snow marks the South Peak. From nowhere on the Icefall, the Western Cwm, the Lhotse Face, or the high South Col could the British climbers glimpse their ultimate goal. True summit was always hidden by intervening ridges, as it is here.

Men of Iron: → Sherpas Who Carried to Highest Camps

Natives of Nepal's Solu Khumbu district, the Sherpas recognize no names, making no distinction between masculine and feminine. Some use surnames denoting the day of the week they were born: *Nima* for Sunday, *Pasang* for Friday. Others adopt the prefix *Ang* for "little," or "son of."

Beside Noyce (left) kneels Pasang Phutar, who carried the heaviest load to the South Col Center, one hand on ropes. Is Dawa Thondup, 49-year-old veteran of Nanga Parbat, Annapurna, and Everest expeditions. Next to Charles Wylie (right) squats 16-year-old Ang Tsering, baby of the group. Da Tensing, unpendersed Sherpa in back row, won the whole party's respect for his courage. Many of this group merit honorary title of "Tiger," given by the Himalayan Club to porters who have distinguished themselves on the high peaks.

D-Day Minus Two: → First Team Moves Up

Both Bourdillon, ahead, and deputy leader Evans are wearing the closed-circuit type of oxygen set. One oxygen bottle rides high on each pack frame. Beneath it are white soda-lime canisters, used for purifying air, and a metal box containing the breathing bag (page 26).

This British team stayed at the South Col only two nights and a day, to avoid the deterioration affecting men at supreme altitudes. Their objective: to reach Everest's South Peak, appraise the final ridge, and, if feasible, go on to the top.

↓ Lives Hang on This Oxygen Set Check

In the sun-baked, protected valley of the Western Cwm, Bourdillon and Evans suffered from the heating effect of their breathing sets. But as they rose into the cold, bitter atmosphere of Everest's upper ridges, they appreciated the warm, moist air filtered into their masks and the lift of inhaling pure oxygen.

Endpapers by Alfred Gregory (above) and George Lowe

Hillary Keeps Track of Team's Progress on Walkie-talkie

Because the Western Cwm's jumbled terrain interfered with radio communication from Camp IV down to base, messages were relayed up to Camp VI on the Lhotse Glacier and bounced back above the obstructions to the camp below the Icefall (map, page 10).

Eager to get word to his fellow Sherpa, Da Namgyal, Tenzing was once persuaded to use the walkie-talkie. The connection proved clear enough, but both men suffered stage fright. After several fruitless exchanges of "Oh, Da Namgyal!" and "Oh, Tenzing!" the conversation died.

Here Hillary, at Camp IV, puts in his usual 5 p.m. call to George Lowe at Camp VI.

Tenzing and Hillary Get Ready to Launch the Expedition's Second Assault

While Evans and Bourdillon rested a day for their attempt on the summit, the second team started moving into position in case the first attack should fall short. Tenzing's oxygen set, working fine here at Camp IV, later choked up with ice. Flags are wrapped hopefully around his ice ax for display at the top (page 58).

II. The Conquest of the Summit

By Sir Edmund Hillary, K.B.E.

This personal narrative was related by Sir Edmund to Beverley M. Bowie of the National Geographic Magazine *Editorial Staff*

NIGHT on the South Col. The wind screeches across the ridge and sets the canvas cracking like a rifle range; an awful noise. I'm braced between Tenzing and the tent wall, no room to stretch out. Whenever my head falls back against the roof it's as if I'd run my brain into a pneumatic drill.

The other side of Tenzing are Alf Gregory and George Lowe, hunched up in their sleeping bags, twisting, heaving around, trying to find some position less cold and miserable. We're using the oxygen sleeping sets, one liter per minute. Makes it easier to doze. But up here you dribble a good bit in your sleep, and when your bottle gives out you wake up suddenly, as if somebody had turned on the light, and your rubber face mask is all clammy and frigid.

I keep looking at my watch, wondering if it's stopped. The hour hand finally creeps around to 4, and I strike a match. The thermometer on the tent wall reads: −15° F. It is still pitch dark.

I nudge Tenzing, mutter something about breakfast, and retreat callously to my bag. Pretty soon the primus has warmed the tent a few degrees—just enough to make it seem safe to sit up and eat. Scruffy, cramped, somewhat depressed, we gulp down cups of sugary hot water flavored with lemon crystals, munch some biscuits, and argue about which one of us has spent the worst night.

Snow Blown Inside Tent

Greg claims the honor, contending that sleeping between Lowe and Tenzing is like being caught in the jaws of a vise. But Lowe scores heavily when he points to a small heap of snow on his sleeping bag, blown through a pinhole in his side of the tent. Scraping it off, he grins at us and says:

"Well, at least you're having a good holiday. I hope you're feeling better for it."

Nobody bothers to answer. We sprawl about for five hours, waiting for the wind to die down. It doesn't.

At 9 I bundle up and stumble over to John Hunt's tent, which he's sharing with Bourdillon and Evans. John agrees we must postpone the attempt. He decides, too, that everyone but Greg, Lowe, Tenzing, Ang Nyima, Pemba, and I should go down; no point in depleting the slim reserves of food we've hauled up here.

An hour or so later they are packed and ready. Hunt, gray and drawn but with his blue eyes frostier than ever, grips my arm. Above the howling wind he says:

"Most important thing—is for you chaps—to come back safely. Remember that. But get up if you can."

We watch them slog across the col, up the ridge, and down the slopes toward the traverse: four tired figures dwindling against the monstrous icy face of Lhotse. Then we turn back to our own chores.

I spend the afternoon sorting oxygen bottles, strapping them to their frames, and preparing our sleeping sets. All day we have used no masks. We can breathe well enough, but we work very slowly.

Altitude Sickness Fells One Sherpa

Night comes on, with the wind still intent on blowing us off the col. We cat-nap through the long hours, not as uncomfortably as before, since there's now more room. Tenzing and I have appropriated the Meade tent for ourselves; Greg and Lowe share the pyramid.

By 8 a.m. the wind has eased off; but when I go to fetch Pemba I find him at the door of his tent, retching his heart out. Obviously he won't be going anywhere today. Which leaves us only Ang Nyima to help on the carry. Blast old Pemba, I think to myself, and with no remorse; the South Col is too high for pity.

We repack our loads and shove off. Lowe, Gregory, and Ang Nyima leave first, at 8:30, with about 45 pounds apiece; they will cut steps for us, so that we can save energy and oxygen. We follow at 10, carrying our sleeping bags, air mattresses, food, and extra clothing on top of our breathing sets (page 52).

At the foot of the big couloir we climb up the staircase Lowe has chipped, only to duck as a rolling barrage of ice chunks splatters down at us from 300 feet above. We have to pull aside until the fellows up top have moved out along the Southeast Ridge. Then we

↑ On Snow-plumed South Peak, Evans and Bourdillon Stood Higher than Any Men Before, Only 300 Feet Lower than True Summit

The first assault team hoped to ascend Everest's last 1,200 feet directly from the South Col without an intervening overnight camp. At 7:30 a.m. on May 26 they set out, using closed-circuit oxygen sets. Climbing strongly, they covered nearly 1,000 feet in an hour. But halfway up they ran into fresh snow which provided a poor grip for crampons. Then Evans's oxygen set began to fail.

At 1 p.m. Evans and Bourdillon achieved their first objective: the South Peak, 28,700 feet. Unfortunately they had neither time, oxygen, nor strength left to tackle the final ridge.

→ At 4:30 that afternoon, two weary figures, utterly spent, stumble down the last slope to Camp VIII.

scramble after them and catch up about noon at the site of the wind-ripped tent left there by Lambert and Tenzing in 1952.

A nice view from here. We photograph everything in sight and move up to the dump John Hunt had placed at 27,350 feet two days ago (page 1). The idea of adding another ounce to our loads brings no cheers from anyone. But the stuff has to go up. Greg packs the oxygen, Lowe ties on some food and fuel, and we all look at the tent.

Campsite Slants Like a Barn Roof

Finally I say to George: "Look, I'll take the tent if you'll make the route."

He grins and moves off in the lead. He's going extremely well. In fact, this is George's big day on Everest. He was good on the Lhotse Face, but up here he's really showing what he can do (page 53).

With 50 to 65 pounds on our backs we plug on up the steepening ridge. By 2 p.m. we start casting around for a tent site, but the whole slope pitches away like a barn roof. For half an hour we search, climbing and traversing, until finally we come on a ledge about 6 feet by 4, angled downward at about 30°.

"Now, there's a lovely spot for a camp," says George enthusiastically, and dumps his load on it at once.

The others are pretty keen to get on down the mountain, too, and we can't blame them. Ang Nyima, though he's dead beat, asks politely if he can stay up here to help us down the next day, but we send him along. One more night this high on Everest would weaken him so much he'd be of no use to himself, much less to us.

A lonely moment, watching old George and

Greg and Ang Nyima turn back. Now we are really alone.

The tent is our first job. For two hours we scrape at the rocks and the snow and the frozen gravel, trying to make a platform for it. We settle for two terraces about a yard wide, six feet long, and about a foot different in height. Then we spend another two hours getting the tent itself up and securing it to some flimsy rock belays and to oxygen bottles which I bury in the snow.

About 6:30 we crawl into our sleeping bags, light the primus, and get some supper: tinned apricots, dates, sardines, biscuits, jam, honey. The wind comes in gusts. When I hear it whistle up on the ridge, I brace myself against the canvas and try to hold the tent down as it gets ready to take off. In between squalls I doze, slumping on the upper shelf with my legs dangling over onto Tenzing's bench.

We use only four hours of oxygen, in two-hour shifts. In between, Tenzing heats up a few drinks. We don't talk much. I wonder to myself how George and the boys fared going down, what John Hunt must be thinking, even how those bees of mine back in New Zealand are getting along. And over and over again I do my mental arithmetic on the amount of climbing oxygen we have left, the amount we're likely to use, the amount that may still be left in the bottles Tom and Charles cached on their way down from the South Peak.

Four a.m. We poke our heads out of the tent door. The wind is mercifully still. Far off, the valleys of Nepal still sleep in darkness, but the summits of Makalu and Ama Dablam have caught the sun; and Tenzing, pointing past me, picks out the monastery at Thyangboche, 14,400 feet below us, where even now the lamas are offering special prayers for our safe return (pages 13 and 18).

Boots Frozen Stiff as Armor

While Tenzing melts water for our tea, I haul the oxygen sets inside, knock the ice off the valves, and test them. My feet had been a bit damp the night before and, in order to let them dry out and warm up, with less risk of frostbite, I had pulled my boots off and used them to prop the toe of my sleeping bag off the cold ground. Now the boots are frozen as stiff as medieval armor.

I cook them over the primus. It takes me a good hour to thaw them, and the smell of leather and rubberized fabric toasting in the little tent is gruesome; but finally the boots are soft enough to wiggle into, and we can set out. Tenzing breaks trail through the powdery snow until my feet have warmed up; then I take over the lead.

Climbing strongly, with a good sense of reserve power, we make for the hollow where Evans and Bourdillon left their oxygen bottles. The cylinders are easy to spot. Pawing the ice from the gauges, I read the pleasant news: about 1,000 pounds pressure—enough to take us down to the South Col if we're lucky. In short, all the oxygen on our backs we can plow into our attack on the peak itself and our return to this niche.

Tackling the South Peak's Face

We push on. About 400 feet from the South Peak we are brought to a stop: which route? Bourdillon and Evans took the ridge to the left; then, on their way back, came down the broad face. But I think the ridge looks jolly dangerous, with all that loose snow masking the rocks. We decide on the face.

You can't zigzag up a steep slope like this or you'll undercut it and find yourself aboard an avalanche with a one-way ticket to the bottom. So we go straight up. At least, we go up five steps, walking on eggs, and then the whole crust for 10 feet around breaks up and we slide down again three steps. We don't so much climb the face as swim up it.

Halfway, I turn to Tenzing and say: "What do you think of it?"

"I don't like it at all."

"Shall we go on?"

He shrugs. "Just as you wish."

I make a quick decision. In ordinary mountaineering terms, the risk isn't justifiable. I know that. But this is Everest, and on Everest you sometimes have to take the long odds, because the goal is worth it. Or so I try to convince myself.

We go on, and we get a break. A few yards higher up we run into some snow that's packed harder. Chipping steps, we make our way quite rapidly up to the crest. At 9 a.m. we are standing on the South Peak (page 55).

We have these advantages over Evans and Bourdillon: Thanks to a higher camp, we're here four hours earlier, and we have more oxygen and more strength left to finish the job. But just how big a job is it? That's something no one can tell us for sure.

To size it up, we scoop out a seat for ourselves just below the South Peak, remove our

Second Team, Supported by Gregory, Lowe, and Sherpas, Crosses Lhotse Face

Part way across this traverse, George Lowe saw Evans and Bourdillon, the earlier team, disappearing over the South Peak. Thinking they would surely reach the top, he danced about, shouting unintelligibly through his oxygen mask. Hillary shook his head sadly, told himself "Old George has had it," and plodded onward. Only when Evans and Bourdillon returned could Lowe be convinced they had not succeeded.

masks, and study the summit above. The true crown is out of sight, somewhere up above the ridge that turns its blade right in our faces now. It looks a fair cow, all right, as we'd say in New Zealand. Cornices on the right, overhanging a little drop of 10,000 feet to the Kangshung Glacier on Everest's eastern flank; on the left, steep snow sloping to the lip of the big rock wall that looms over the Western Cwm (page 60).

We don't need to talk much. It's obvious that our only route lies between the cornices and the cliffs on the left; the joker is the state of the snow. If it's firm, we have a chance. If it's loose and dry, we've come a long way for very little.

I check the oxygen once more. One full bottle left for each of us. That's 800 liters at three liters per minute—about 4½ hours of climbing. Enough? Well, it will have to be.

We put our sets on again, lighter for the discarded bottles. I feel very fit, and keen to get at the problem. We crampon down to the start of the ridge, and I sink my ax blade into the snow of the upward slope. It is everything we could have asked—crystalline and solid and well packed. Two or three whacks chip a step big enough even for our elephantine high-altitude boots, and a good shove buries the ax shaft half its length, making a very decent belay.

Tenzing's Breathing More Labored

I lead off, cutting a 40-foot line of steps, resting, and taking a few turns of the rope around my ax as Tenzing comes up to join me. Then he belays me as I carve another flight. We move along steadily, giving the rickety cornices a fairly wide berth and taking an occasional gander over the rock face on our

Bone-tired and Bent,
the First Team
Staggers into Camp

The last dangerous passage for the weary returning pair was an icy chute above the South Col. Dazed, Charles Evans slipped, shot past Bourdillon, and yanked him off his feet. Together they tobogganed down the 1,100-foot ravine. Bourdillon jabbed his ice ax into the snow as a brake, and gradually they slowed in time. Said Evans (left) of their escape: "I couldn't have cared less."

◆ Portrait of a Leader:
Hunt Chose to Command
"From Up Front"

Selflessly concerned only with putting his strongest climbers in position to strike for the top, the leader elected the grueling task of carrying supplies up from the South Col for Hillary and Tenzing. Though ice partially blocked his oxygen valves, he struggled up to 27,350 feet. His instructions to Hillary: Don't give in, but get back.

Kodachromes by Alfred Gregory (above) and Sir Edmund Hillary (left)
© Time Inc. and Royal Club

left. About 7,500 feet below I can just make out the tents of Camp IV, and I flap my arms up and down like an Abominable Scarecrow, with no particular hope that anyone will see me.

Tenzing has begun to drag a little on the rope by now, and his breathing seems more rapid. As we halt on one tiny ledge, I ask:

"How does it go, Tenzing?"

"All right."

I know, however, that like most Sherpas Tenzing has only a vague notion of the way his oxygen set works. He may be getting groggy and not even realize it. So I check his exhaust tube and find the valves almost completely blocked with ice; he's probably been getting no great benefit from his oxygen for some minutes.

I examine my own tube; to my surprise, ice has begun to form here, too, though not enough yet to interrupt my air flow. Obviously, this is something I'll have to keep an eye on for both of us. Fortunately, my habit of doing mental mathematics on our oxygen supply as I plug along, plus the fact that I'm leading the rope, will keep me fairly alert.

We resume the climb, and I cut another line of steps for perhaps half an hour. Then we find ourselves staring at an obstacle we've dreaded ever since we spotted it on the aerial photos and through our binoculars from Thyangboche: a ghastly great rock about 40 feet high, plunked down right across the ridge. No route on it worth talking about. And no way around it except—

Except where the snow cornice on the right, pulling away a little from the rock, has left a thin gap, a kind of chimney.

Forty Feet in Half an Hour

We look at it with rather mixed emotions. I'm not one of those blokes who says to himself, "I'll get up, come hell or high water." Mountains mean a lot to me, but not that much. I just say to Tenzing:

"Well, we'll give it a good go."

He takes a belay, and I jam my way into the crack. With my back to the cornice, I face the rock and grope for handholds along it, kicking my crampons into the snow behind me and jacking myself upwards. I use everything I have—knees, elbows, shoulders, even the oxygen set on my back—trying to get a purchase and exert some critical leverage.

My tactics depend on one little consideration: that the cornice doesn't peel off. Of course, Tenzing has me belayed on a bit of rock, which provides a certain moral support. But if the snow gives way, and I find myself dangling over the Kangshung Glacier, it isn't going to matter enormously whether Tenzing can hold me for five minutes or fifty.

Foot by foot I hump and wriggle and pull myself up the chimney. The crack is only a rope's length long, but it's a good half hour before I can reach over the ledge at the top and drag myself onto it. I lie there, panting like a gaffed fish, surprised somehow that I've scraped together enough energy to make it. Then I give Tenzing a taut rope and signal him to come along. For the first time the conviction seeps through me that we are really going to go all the way.

Always Another Ridge Ahead

I check the oxygen sets again. The flow rates seem all right. Turning to Tenzing, I say: "How do you feel?"

He just grins and waves his hand upward toward the ridge. I lead off once more, cutting steps. My ax work is still pretty rhythmical and relaxed; I've been chipping away for well over an hour, but, so far, I've avoided the kind of tension that can turn up a sore arm.

One flight of steps, then another, and another. We follow the ridge as it curves around to the right, wondering where the top can possibly be, or if it exists at all. I cut around the back of one crag, only to have a higher one stare me in the face. It seems endless.

Tiring, I try to save time on one stretch by skipping the step cutting and relying on my crampons. After a few yards I go back to my ax; the angle is still too steep, too dangerous. The zest we have known at the top of the rock step is draining away. Dully, grimly, I hack a route around still another knob.

Standing on Top of the World

Suddenly I realize that the ridge ahead doesn't slope up, but down. I look quickly to my right. There, just above me, is a softly rounded, snow-covered little bump about as big as a haystack.

The summit.

One last question concerns me: is the top itself just a large, delicately poised cornice? If it is, someone else can have the honor of stepping on it.

I cut my way cautiously up the next few feet, probing ahead with my pick. The snow is solid, firmly packed. We stagger up the

In Thin, Parched Air Hillary and Tenzing Toil Up Steps Cut by the Support Party

After two miserably cold nights on the South Col with the wind trying to flick their tents off the mountain, the second team and its three-man support party set out to establish the last camp at 27,900 feet. Hunt was determined that one of his two assault teams should camp just short of the South Peak itself.

→ On this forlorn, rock-strewn ledge on the way to Camp IX, Hillary and Tenzing take a breather. Razor-edged peak of Makalu, 27,790 feet high, lies above mist behind Hillary's shoulder.

Doffing his oxygen set for a few minutes, Hillary found no difficulty breathing at this altitude of 27,250 feet, proving how well he had acclimatized. Had he been using a closed-circuit model, however, relying upon pure oxygen, he would have removed it only at the risk of loss of consciousness.

Near here the British party found tattered remnants of a tent in which Tenzing and Swiss guide Raymond Lambert had spent a gruesome night with no sleeping bags and no cook stove on their courageous but unsuccessful attack the previous spring. The Swiss effort seemed to underline Hunt's general thesis: Everest cannot be rushed.

Uptilted Rocks of Everest's South Face Provide Holds for Lowe's Hands and Boots

One great hazard faced by climbers approaching Everest from the Tibetan or northern side is the downward slope of the rock layers forming the summit. Upturned slabs on southern ridges offer a much safer grip.

Here Lowe leads the rope toward a supply dump cached above by Hunt and Da Namgyal two days before. At this niche on the Southeast Ridge the five climbers picked up additional oxygen bottles, food, and fuel, increasing their total loads to as much as 55 pounds apiece.

With only a brief respite from his ordeal on the Lhotse Face (page 38), Lowe cheerfully threw himself into the backbreaking dual job of portering and cutting steps up to Camp IX. Said Hillary: "This was George's biggest day on Everest."

Photographed by Alfred Gregory © N.G.S. and Alpine Club

final stretch. We are there. Nothing above us, a world below.

I feel no great elation at first, just relief and a sense of wonder. Then I turn to Tenzing and shake his hand. Even through the snow glasses, the ice-encrusted mask, the knitted helmet, I can see that happy, flashing smile. He throws his arms around my shoulders, and we thump each other, and there is very little we can say or need to say.

My watch shows 11:30. Two hours and a half it has taken us from the South Peak; five hours from our tent. It seems a bit longer.

Photographs Prove Summit Was Reached

I turn off my oxygen and remove my mask. In the thin air of 29,000 feet my breathing becomes slightly more rapid, but not too uncomfortable. I fish out the camera I have kept warm inside my shirt; it will be necessary to take shots down every ridge if we're to prove conclusively that we've been up here.

Moving down the cone a few feet, I snap a picture of Tenzing holding up his ice ax with its flags standing out stiffly in the wind—the flags of the United Nations, Great Britain, Nepal, India (page 58). It would be nice to have Tenzing take my portrait, too, in some heroic pose, but unfortunately he doesn't number among his many virtues a knowledge of photography, and the top of Everest strikes me as a poor place on which to conduct classes.

We look about for any signs that Mallory and Irvine may have been here before us; there are none. I take care, however, to photograph the route which they and the other great climbers followed up from the North Col and along the rugged Northeast Ridge (page 59). Then I point the camera hopefully at unclimbed Makalu, at the fantastic bulk of Kanchenjunga on the far horizon, at Cho Oyu to the northwest, at the ranges of Nepal receiving into the distance, wave on glittering wave (page 56 and map, page 11).

Scooping a small hole in the snow, Tenzing buries a few offerings to the gods that many Buddhists believe inhabit these heights: a small blue pencil given him by his daughter, a bar of chocolate, some biscuits, a cluster of lollypops. I place near these gifts a little crucifix that John Hunt has received from a friend and passed over to me on the South Col.

It's time to go down now. I replace my oxygen mask, suck the air in gratefully, and move off without a backward glance. Reaction has set in; we both are tired.

We crampon along the steps I have cut, moving fast. We know the route: we know what's ahead and what isn't; the certainty gives us confidence and a lift to our stride. Even the rock chimney looks reassuringly familiar; we pop into it and kick our way down as if there's no more danger that the cornice will politely take leave of the ridge.

Back on the South Peak once more, we halt for a swig of lemonade before tackling the section we both dread, the great snow slope on the reverse face. This nasty bit of work skids down the summit at an oblique angle aimed right at the Kangshung Glacier. An ice-ax belay won't hold in the soft snow. If one of us begins to slide, both of us will enjoy a 10,000-foot jump without benefit of parachute.

Inching Down a Glassy Staircase

We begin our descent of this glassy staircase. Facing outward and down, we get the uncomfortable sensation of being too heavy, ready to sway forward and fall. We place our boots down onto each step as if we're walking a high wire. I mutter a few things under my breath when we come to a flight of steps Tenzing has cut with his usual ambitious spacing; I have to stop and chip a new step between each of his.

Forty steps more. Twenty. Five . . . we

(Continued on page 62)

One False Step onto South Peak's Cornices Might Mean a Drop of Nearly Two Miles

On May 28 Hillary and Tenzing spent an uneasy night alone on a tiny ledge at 27,900 feet. At 6:30 next morning they moved gingerly up the South Peak's treacherous snow face, topped it at 9, then climbed along this footprinted ridge. Photograph, taken halfway to the goal, shows how their route kept cautiously to firm footing where snow met the rocks. The cornices, apparently substantial drifts, are in reality wind-created lips of snow overhanging a chasm precipice. Climbers steered clear of them lest they suddenly collapse.

At one point on this difficult spine, however, Hillary confronted an obstacle he had glimpsed previously on photographs and long dreaded: an almost vertical 40-foot rock step, impossible to skirt and with too sheer a face to climb at this enervating altitude.

To one side he discovered a kind of chimney where the cornice had pulled away from the rock. Wedged in, his back pressed against the snow, Hillary inched his way up, hoping the cornice would not abruptly peel off into space. It held; and half an hour later he crawled out at the chimney's top, exhausted but now confident that nothing would stop them.

Kodachrome by Sir Edmund Hillary © N.G.S. and Royal Club

From Earth's Summit: Lonely, Barren World of the Himalayas

Wave on icy wave, a sea of snow-crested peaks stretched at Hillary's feet to the farthest horizons, 150 miles away. In a chilling 360° panorama, his eye embraced hundreds of great mountains from Tibet in the north to Sikkim in the east and Nepal in the south and west. Only a handful of these Himalayan giants have been explored, fewer still surmounted.

Above: To the southeast rises the jagged pyramid of Makalu (right). Actually a good 12 miles distant, it looks like an adjoining spur of Everest. A mountaineer to the core, Hillary turned from his own conquest to wonder whether a feasible route could be found to the summit of this 27,790-foot virgin peak, target of an American expedition in 1954.

Brutal bulk of five-summited Kanchenjunga, world's third highest mountain, dominates the horizon on the far Sikkim border.

Left: Scanning northwestward, Hillary's camera looks down on the coiling highway of West Rongbuk Glacier, used as a passage by earlier expeditions approaching Everest through Tibet.

Sir Edmund Hillary
© N.G.S. and Alpine Club

May 29, Day of Victory: Tenzing Stands on Top of the World

Weary and chilled, Hillary had begun to wonder if Everest had any summit at all. Then he chipped his way by a last corner, realized that the route ahead pitched downward, and saw over his right shoulder a little rounded cone. Above it—nothing. A few more steps, and he and Tenzing stood in triumph upon earth's highest pinnacle.

In holes scooped in the snow, Tenzing buried small gifts to his Buddhist gods, Hillary a crucifix. Taking off his oxygen mask, Hillary snapped many pictures but none of himself. "Tenzing is no photographer," he said later, "and Everest was no place to begin teaching him."

Flags of the United Nations, Great Britain, Nepal, and India flutter from Tenzing's ice ax.

Reconstruction by Sir Edmund Hillary

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Sir Edmund Hillary © R.G.S. and Alpine Club

Everest's Northern Ridge: This Picture Proves Hillary Reached the Summit

Only from the mountain's crest could Hillary and Tenzing, ascending from the South Col, have looked down upon this lethal spot, route of all prewar Everest parties. Mallory and Irvine, attempting it 29 years earlier, were last seen at about 28,000 feet. Hillary found no trace of them at the top.

← **Snowprints Outline Route of Conquerors Descending the Summit**

Safely back on Everest's South Peak, Hillary photographed the final ridge that only he, Tenzing, Bourdillon, and Evans have ever seen from the ground. Retracing their route down this snow-crested rib, the summit pair treated former hazards with an almost jaunty assurance. Hillary popped into the fearsome rock chimney and scrambled down it as if it were no worse than a rickety barn ladder. Only on the South Peak's reverse slope, where powdery snow would hold no belay, did their anxiety return.

→ Gregory and Bourdillon escort a tired Hillary to Camp IV after his 4,000-foot descent from the South Col, May 30.

↓ Between endless cups of tea, Tenzing and Hillary tell and retell the story of the team's great victory to their comrades in the Western Cwm. Happy as Hillary was, exhaustion made him feel as if it were all happening to someone else.

Reminiscences by Sir Edmund Hillary
compiled and George Band
© E.P.D. and Alpine Club

are down and can slant over to the relative safety of the Southeast Ridge. We look at each other, and with a kind of sigh shrug off the weight of fear that has sat on our shoulders all this long day. The worst is over; we are nearly down.

Picking up the reserve cylinders left by Charles and Tom, we trek down to our dismal little campsite; already the wind has ripped the tent half away. It is 2 p.m. Tenzing heats up some more lemonade on the paraffin stove, while I change our oxygen sets onto the last bottles and cut the flow rates down to two liters a minute. We sip our drinks, looking rather dazedly down at the South Col where a couple of dots that may be Lowe and Noyce move out now from the camp.

On our feet again, we load up our air mattresses and sleeping bags and stumble off, numb with exhaustion, to the top of the couloir. Here we get a rude surprise: the wind has wiped out all the steps we cut the day before, leaving only a smooth, frozen slope beneath us. With a grunt of disgust, I start chipping a new flight, 200 feet down the gully, pausing only when a particularly vicious gust tries to tear me loose from the mountain and forces me to dig my ax in fast and hang onto it, shielding my face from the pelting snow.

Once at the couloir's foot, it's only a long, rough tramp down to the South Col. Before we get there, a lone figure stumps up to meet us—George Lowe, carrying hot soup and emergency oxygen. I grin weakly at old George and say:

"Well, we knocked the blighter off!"

It is rather pleasant to see his face light up. We have climbed a good bit together, George and I, and it does me good to have some decent news for him after all he and the others have been through to put our team in position. But both Tenzing and I are too fagged to chatter much about our experiences.

We totter down to the camp. My oxygen gives out before we get there; it doesn't seem to matter much any more. We crawl into the tents and collapse on our sleeping bags with a sigh of sheer delight.

Excitement Prevents Sleep

Yet we sleep very little that night. The wind, the bitter cold, the delayed-action burst of excitement within us keep us awake, keyed up, reliving the best and the worst passages of the long assault. By morning we are quite weak, though by no means truly exhausted.

We pack up. It takes us longer than it should; Everest, right up to the end, is making us pay for the liberties we have taken with its heights. Trudging up the 200-foot slope above the South Col, we begin the grueling traverse across the Lhotse Face.

Tenzing and I have treated ourselves to the luxury of oxygen on the way down. We don't need it terribly; but we figure that perhaps we've earned it. Even so, we have to move slowly.

As we clamber down the ice steps to Camp VII, which we have assumed is deserted, we're startled by a loud, cheerful shout. It's Charles Wylie and his Sherpas, bolting out of the tents to greet us and press hot drinks into our numbed hands. Charles's voice has a curious effect on me; it seems so unnaturally strong and vital and fresh after our days of deterioration up above that I feel suddenly very relaxed and confident, as though sure at last that everything is going to come out all right.

Our news has an equally pleasant effect on the Sherpas. They crowd around and shake our hands, saluting Tenzing—one of their own—with a new and even more affectionate respect. I hear the phrase popping up here and there:

"*Everest khatm ho gya*, Sahib! Everest has had it!"

For the Whole Team: Victory

Camp VII, however, is no hotel, and we are eager to get off the mountain. Pressing down the Lhotse Glacier, past Camps VI and V, we break out into the upper cwm itself and push along the snowy route toward Camp IV. As we get within sight of it, we see little figures emerging and making their way up the track toward us.

We make no signal until they are about 50 yards away. Then old George jerks his thumb up and waves his ax in the direction of the summit. Instantly, with a whoop, the advancing group breaks into a run. Weak as they are, they rush the remaining yards and fling themselves upon us. John Hunt, too tired to do much more than smile, puts his arm around me and lets his head fall on my chest.

It is a strange and moving moment. I am so weary myself that it is as if I were standing some distance away and watching all this happen to another person. All I know is a great gladness that we can bring back to John the victory he did so much to achieve.

Holi Dust and Garlands of Frangipani Decorate the Victors at Katmandu

In these elegant garments, Hillary, Hunt, and Tenzing were received by the King of Nepal and his court after the 2-week trek down from Everest's base. Griffith Pugh attended the royal ceremony in the same pair of pajamas he had worn on both march-in and march-out. Jubilant Nepalese tossed red Holi powder at the climbers as a signal honor; usually this talclike dust is flung or squirted about only on Holi day, sacred Hindu festival of spring.

Hunt's party found it somewhat harder to convince the Abbot of Thyangboche that Everest had been conquered. When the climbers stopped at the monastery on their way back to Katmandu, the elderly lama asked Tenzing if he had met the gods on the summit. "No? Then you failed to reach the top. I am so sorry."

Though factors of wind, snow, and the climbers' own fitness had determined the date for Everest's final ascent, the news arrived in London by happy coincidence on the eve of Coronation Day, June 2, 1953. At Base Camp the climbers listened by radio to acclamation of their feat. "Until we heard it officially announced, we didn't really believe it ourselves," said Hillary.

National Geographic Photographer J. Baylor Roberts

President Eisenhower Presents the Hubbard Medal to Everest's Conquerors

Eight Presidents have honored the National Geographic Society by bestowing its Hubbard or Special Gold Medals upon such noted explorers as Peary, Amundsen, Shackleton, and Byrd. Here the present Chief Executive congratulates Sir Edmund Hillary (shaking hands) and Brigadier Sir John Hunt, C.B.E., D.S.O., leader of the British Everest Expedition, during ceremonies on February 11, 1954, at the White House. From left, British Ambassador Sir Roger Makins, Dr. Thomas W. McKnew, Dr. Melville Bell Grosvenor, Dr. Gilbert Grosvenor, and (far right) New Zealand Ambassador Leslie Munro. Others present included Robert V. Fleming, treasurer, and Leroy A. Lincoln, trustees of The Society; Charles Evans, George Lowe, and James Morris of the Everest team, and Elliott B. Macrae of the American Everest Committee.

"It is a great honor to serve on behalf of the National Geographic Society in carrying out this pleasant duty."

With these words, President Dwight D. Eisenhower presented The Society's Hubbard Medal, its highest honor, to the British expedition which climbed Mount Everest in 1953.

The President congratulated Sir John Hunt "upon carrying through an expedition which has excited the admiration of the entire world."

In accepting the award in behalf of the expedition, Sir John said, "We are not exactly surprised that in this great country of yours so much store is set on an enterprise such as the ascent of Mount Everest, which is the epitome of adventure and high endeavor."

President Eisenhower also handed bronze replicas of the gold original as personal awards to Sir John and to Sir Edmund Hillary. A replica was personally presented to Tenzing Norkey in India by United States Ambassador George Allen. The Royal Geographical Society and the Alpine Club, expedition cosponsors, also received duplicates.

Dr. Gilbert Grosvenor, president of the National Geographic Society, thanked Mr. Eisenhower for the encouragement he gave to The Society's mapping and scientific programs both as World War II Allied Commander in Europe and later as President of Columbia University.

"And now today," he continued, "you enable the 2,150,000 members of The Society to give the greatest possible American distinction to the British Everest Expedition by presenting to them the Hubbard Medal."

The Everest lecture delivered the next day by Sir John, Sir Edmund, Dr. Evans, and Mr. Lowe in Constitution Hall and illustrated with color photographs was one of the most successful The Society has presented in the 66 years of its meetings. Attendance at the matinee and evening performances totaled 7,200.

In his introduction, Dr. Grosvenor termed the occasion one of the most memorable in the history of the National Geographic Society.

"It is only to be compared," he said, "with the days when Robert Peary came to recount the discovery of the North Pole, Richard Byrd to describe his flights across the North and South Poles, and Charles Lindbergh to tell of his solo flight across the ocean."

Gilbert Grosvenor Is Elected Chairman of the Board, John Oliver La Gorce Chosen President and Editor of the National Geographic Society

DR. GILBERT GROSVENOR, Editor of the NATIONAL GEOGRAPHIC MAGAZINE for 55 years and President of the National Geographic Society since 1920, requested permission to retire in a letter read to the Board of Trustees at its meeting May 5, 1954. The Trustees voted to accept his retirement, on condition that he become Chairman of the Board. Thus he will continue actively his lifelong interest in geography and the National Geographic Society.

Dr. John Oliver La Gorce, for many years Associate Editor of The Magazine and Vice President of The Society, was elected by the Trustees to succeed Dr. Grosvenor as Editor and President. Dr. Melville Bell Grosvenor, Senior Assistant Editor, was elected Vice President and Associate Editor.

Dr. Robert V. Fleming continues as Treasurer of The Society, and Dr. Thomas W. McKnew as Secretary.

Grosvenor Carried Whole Issue on Back

In his letter Dr. Grosvenor said:

"GENTLEMEN: April 1, 1954

"On April 1, 1899, on the recommendation of Alexander Graham Bell, then President of the National Geographic Society, you engaged me to help you create a NATIONAL GEOGRAPHIC MAGAZINE that would arouse so much interest in Geography that many people would want to become members of our Society.

"We hoped also that eventually The Magazine would furnish a surplus above expenses that we could use for exploration and other geographic research undertakings.

"By working harmoniously together, and with splendid cooperation from our members, the National Geographic Society and its Magazine have progressed beyond our fondest hopes.

"I addressed the envelopes of the first number that I edited, April, 1899, and then carried the entire edition on my back to the post office on one trip. The April, 1954, edition would fill a bookshelf 10 miles long, and to accommodate the 26,000,000 copies printed in 1953, a bookshelf extending from Washington, D. C., to Philadelphia, 135 miles long, would be required.

"Being blessed with good health and a devoted wife, by God's grace I have had the honor, for 55 years, of assisting you in the world-wide educational work of the National Geographic Society for 'the increase and diffusion of geographic knowledge.'

"In my long service I have made many thousands of decisions affecting the welfare of The Society and its Magazine. But I cannot recall a single instance of harsh, discouraging criticism from any member of the Board.

"I have served with 85 members of the Board, every one of them distinguished for outstanding achievement in the Army and Navy and Air Force, in Government service, science, exploration, banking, and industry. Sixty-five of them have passed away, but I recall with affection the face of every one as clearly as if he were standing before us today. Every member of the Board has made notable contributions to The Society's activities.

"On October 25, 1900, Elsie Graham Bell consented to give her magic touch to The Society by marrying me. She has accompanied me on all my many travels for The Society, except on my flight to the North Pole on May 20, 1953, by courtesy of the United States Air Force.

Hubbard Memorial First Headquarters

"In September, 1903, the National Geographic Society moved from rented office rooms to the handsome building erected by the families of Alexander Graham Bell and Charles J. Bell as a memorial to The Society's first President, Gardiner Greene Hubbard, their father-in-law. Believing The Society and its Magazine were set to achieve the program he had initiated, Dr. Bell retired as President but continued as a Trustee until his death in 1922. He was much pleased by the growth of The Society, and in an address to the members in 1912 he declared that the NATIONAL GEOGRAPHIC MAGAZINE had become 'the greatest educational journal of the world.'

"Photographing Alexander Graham Bell's kites, I made my first pictures for the NATIONAL GEOGRAPHIC MAGAZINE in 1903. In the ensuing years The Magazine has published hundreds of my photographs—Russia, 1914; Hawaii, 1924; China, 1938; Norway, 1948; Turkey, 1951; Africa, 1953; the North Pole, 1953; and many of the United States.

"In five years, by hard work I had increased the membership from less than 1,000 to 3,000. But I came to the office one December morning (1904) much discouraged. The printer was urgently demanding copy for 11 pages for the January number. I had no good manuscript available and was at my wits' end. I found a package on my desk. I opened it. There lay before me some 50 beautiful photographs of the mysterious city of Lhasa, Tibet, taken by a Russian explorer. They were offered to the National Geographic Society free, for publica-

66 National Geographic Photographer Barry Linehan

For the Lady with the "Magic Touch": Honorary Life Membership in The Society

In his letter of retirement Dr. Grosvenor wrote: "On October 23, 1900, Elsie Graham Bell consented to give her magic touch to The Society by marrying me." Secretary McKee presents the certificate on behalf of the Trustees to Mrs. Grosvenor, author of "Saint Through Changing Africa," published in the NATIONAL GEOGRAPHIC, August, 1955. Rear Admiral Colbert (left) and President La Gorce join the applause.

"Gilbert Grosvenor the Editor has given the shape and meaning to geography that have brought inestimable benefit and pleasure to countless millions throughout the world. In the span of the lifetime of one man, the National Geographic Society became universally known, admired, and respected. His lifework, that of creating a better understanding of how man lives and works in all the nations of the earth, has contributed more than we may realize to the peace which rises from that understanding.

"Gilbert Grosvenor the Man is possessed of a rare combination of many talents and abilities. But, above all, Gilbert Grosvenor is a man of great kindness and consideration not only to all those associated with him but to all with whom he comes in contact. If he possessed no other attribute, he would be a notable man for this quality alone.

"BE IT RESOLVED, That this Board expresses its admiration, gratitude, and above all, its appreciation to this illustrious man who, as the principal architect and master builder of the National Geographic Society and its Magazine, has been an inspiring example to us who have been privileged to serve with him.

"THEREFORE, BY THIS RESOLUTION, we affirm our highest esteem, respect, and deep affection. We direct that this tribute be spread upon the permanent records of The Society which he did so much to bring to its present state of honor. To us, your fellow Trustees, it has been a high privilege and rich experience to have been associated with you."

Following the adoption of this resolution, which was signed personally by all members of the Board, the Trustees unanimously elected Dr. John Oliver La Gorce President of the National Geographic Society and Editor of its Magazine.

In his response Dr. La Gorce said:

"Dr. Grosvenor and Gentlemen of the Board of Trustees:

"I am greatly honored by your expression of confidence and deeply thank you.

"For nearly half a century it has been my good fortune and happy privilege to be closely associated with Dr. Grosvenor in the service of The Society, and I have profited immeasurably by the years of contact with a truly great, creative editor and the inspirational builder of our world-wide organization of today.

"Gentlemen, with your continued help I shall do my best to carry forward the high standards of the educational and scientific work of the National Geographic Society and its Magazine."

By nomination of Dr. La Gorce, Dr. Melville Bell Grosvenor was then unanimously elected Vice President of The Society and Associate Editor of The Magazine.

To the Depths of the Sea by Bathyscaphe

In the French Navy's Balloon of the Deep, Marine Explorers Enter a "Purée" of Living Creatures and Sight Strange White-eyed Sharks in the Eternal Night of 4,000 Feet

By Capt. Jacques-Yves Cousteau

WHAT is it like to go down to the dark floor of the sea in that wonderful new dirigible of the depths, the bathyscaphe? One day in December, 1953, I found out, descending 4,000 feet into the Mediterranean.

The night before, I had been in Paris, awaiting a signal. Finally it came: "Weather favorable." Catching the Blue Train, I sped toward Toulon and the naval dockyard. Dawn was breaking when I arrived, and I hurried to the slip where this 53½-foot deep-diving submarine, smallest operational unit of the French Navy, was usually berthed, a midget almost lost among the hulking aircraft carriers and tall warships.

No Cables Tie This Sub to Surface

This time, however, the slip was empty. The bathyscaphe had already put to sea, under tow. Boarding a speedboat, I raced after her through the crowded harbor and out into the Mediterranean. A few miles offshore we caught up with the *Elie-Monnier*, the naval research ship acting as a tug, and transferred to her bridge.

Aboard I found my two friends, the now famous deep-diving team: Lt. Comdr. Georges Houot, tall and lean, with a shy grin, and boyish-appearing Lt. Pierre Henri Willm, of the Navy Engineers. We talked animatedly of the day's objective—the Toulon canyon, an undersea gorge about six miles from the harbor—and then I strolled aft to the taffrail and looked back at the bathyscaphe, bobbing and dancing in our wake. Both pride and excitement welled up in me. For this small craft held the promise of an opportunity for which I had worked and waited almost 10 years.

Like the Aqualung (which with Emile Gagnan I had developed in 1943), the bathyscaphe is an independent diving apparatus without lines to the surface.* Compartments holding some 20,000 gallons of light gasoline buoy her up, as hydrogen or helium buoys a balloon. Intimate with the sea, she carries one down from the Continental Shelf, habitat of the Aqualunger, to the ocean deeps. (Her very name, in fact, comes from the Greek words *bathy* for "deep" and *scaphe* for "boat.") Possessed of such a ship, man may now descend far into the sea and gaze from a window at some of the last mysteries of our globe. Why speculate upon future journeys to other worlds while 70 percent of our own planet remains unknown to us?

In 1948 I had taken part in tests of the original "deep-boat"—*F.N.R.S. 2*—with the men most responsible for her: Professors Auguste Piccard and Max Cosyns, the latter of the University of Brussels. The dives of this model off French West Africa had proved the principle sound. To our regret, however, the prototype was unseaworthy. Though she had serenely withstood enormous pressures down below, she was wrecked on the surface in a mild Atlantic swell.

We then campaigned for a new bathyscaphe. One of the most ardent spirits in this cause was the French oceanographer, the late Dr. Claude Francis-Boeuf. As before, too, we had the advice of Professors Piccard and Cosyns and the financial assistance of the Belgian National Scientific Research Fund. Indeed, it was the initials of this progressive Government trust, Fonds National de la Recherche Scientifique, which were to give *F.N.R.S. 3* her name.

The new plans, however, were drawn by the French naval architect, Lt. Comdr. André Marie Joseph Gempp, of the Engineers, with Piccard, Cosyns, and myself as technical advisors. Diver Frédéric Dumas contributed several vital ideas for the design.

Lieutenant Gempp's work was ended abruptly by combat orders sending him to Indochina. He was succeeded by Lieutenant Willm, who with Houot completed the submarine. During construction, Professor Pic-

*The story of the Aqualung, and of a remarkable archeological purpose to which it was put, has been vividly told in the National Geographic Magazine in "Fish Men Discover a 2,200-year-old Greek Ship," January, 1954, and "Fish Men Explore a New World Undersea," October, 1952, both by Capt. Jacques-Yves Cousteau, leader of the National Geographic Society-*Calypso* Oceanographic Expeditions.

French Navy Official

Up from a Sunless World Rises the Bathyscaphe, Pioneer of the Atlantic's Sea Floor

Plucking a page from the prophetic fiction of Jules Verne, French naval designers have constructed a strange, two-man submarine capable of plunging 2½ miles beneath the sea, free of any cables or hazardous connections with the surface. Here an Aqualunger greets the craft as it ascends from the virgin landscape of the depths.

Opposite page: Bathyscaphe's balloonlike hull, "inflated" with some 20,000 gallons of lighter-than-water gasoline, supports a spherical steel cabin weighing 9½ tons when submerged (12½ out of water). Exterior motors drive the ship along the ocean floor at one knot. Lower: Barred porthole peers from bottom of the sub's air lock.

card withdrew to build his own bathyscaphe, the *Trieste*, in Italy, using part of the French plans. We were happy that the world's "bathy fleet" had been thus augmented.

As for me, I looked forward to the coming dive as the greatest experience of my undersea investigations, the more so because of the work I had engaged in for months with Dr. Harold E. Edgerton, of the Massachusetts Institute of Technology,* who invented the stroboscopic flash for high-speed photography.

As part of a National Geographic Society research project, we had been using his automatic electronic flash cameras in the depths from aboard our oceanographic vessel, *Calypso*. Our target was the mysterious "deep scattering layer," often known by its initials —the DSL.

Echoes Bounce Off "Phantom Layer"

The problem of the DSL is a recent one in oceanography, appearing with the advent of the echo-sounding device in the 1930's. In all seas, echo sounders had recorded a puzzling layer or layers, rising by night, sinking by day, between the surface and the actual sea floor, often at 250 fathoms. Even in the mid-Atlantic, expeditions sponsored by the National Geographic Society, Woods Hole

Oceanographic Institution, and Columbia University had found this same "phantom layer."†

What was the DSL? Some scientists at first thought it a stratum of water markedly different in temperature, salinity, or other physical factors. Others decided it was a crowded

* See "Burr Prizes Awarded to Dr. Edgerton and Dr. Van Biesbroeck," National Geographic Magazine, May, 1953.

† See, in the National Geographic Magazine: "New Discoveries on the Mid-Atlantic Ridge," November, 1949; and "Exploring the Mid-Atlantic Ridge," September, 1948, both by Maurice Ewing.

layer of creatures whose bodies reflected the echo-sound beam—perhaps squids, shrimps, or fish, perhaps microorganisms (page 74).

"Papa Flash," as his shipmates called Dr. Edgerton, had lowered his cameras from the *Calypso* at 17 stations throughout the Mediterranean, from Monaco to the Greek islands, making more than 10,000 photographs in this strange zone at depths averaging 1,500 feet.

His film showed shrimps, medusas (a type of jellyfish), siphonophores, and myriads of tiny specks. But in Dr. Edgerton's opinion, instead of solving the problem of the DSL, these pictures proved we had not even begun on it. For—at least in the areas he had worked—the population of animals in the photographs turned out often to be as thick above and below the DSL as it was in the layer itself!

Eye "Closer to Brain" than Lens

This perplexing evidence was fresh in my mind as the *F.N.R.S. 3* approached her diving station. Would our observations justify the money, work, and stubborn belief put into this independent man-carrying vehicle, or would the best way of studying the depths still remain remote-controlled instruments and automatic cameras lowered from ships?

Skeptical, one observer on board asked me if I really expected to see anything that 10,000 photographs failed to record.

"Of course!" I said. "A direct look is something else again."

"After all," added my friend Dumas, "the eye is closer to the brain than the lens. The eye knows how to select."

Houot and Willm had already tested the craft down to 6,890 feet, but, because of the mechanical failure of an echo sounder, had not dared descend farther than some 300 feet from the bottom. Deprived of any accurate gauge of the depth, they were afraid the sheer momentum of their 98½-ton vessel would drive it dangerously into the mud before they could discharge ballast, or crash the delicate hull against some projecting rock.

This fear was very much with us. We had read in the papers that Professor Piccard's *Trieste*, diving off Capri in the previous summer, had plunged to the bottom and partially buried her sphere. Happily, Piccard and his son had been able to discharge ballast, pull out of the mud, and ascend safely.

But neither on this dive nor on others had the bathyscaphe's utility as a real submerged laboratory capable of descending safely to the sea bottom and cruising along it been fully proved. That would be our objective.

For our dive we had chosen the strange canyon off Toulon surveyed recently by our friend, Prof. Jacques Bourcart. As the *Elie Monnier* rounded Cap (Cape) Cépet and headed toward Porquerolles, Lt. Comdr. Georges Ortolan called for soundings. The man at the echo sounder reported: "3,700 feet . . . 3,800 . . . 3,950 . . . 4,020 . . ."

According to Bourcart's isobath charts, we are now floating just above the great submarine valley. The engines fall silent, while our compressors begin to puff-puff, pumping compressed air into the Aqualungers' tanks.

By motor launch, Houot, Willm, and I chug over to the submarine. I feel a certain sympathy for Willm; today he will be giving his place on the deep-boat, his baby, to another for the first time. And he seems a good deal more anxious about our dive than we are.

Houot enters the conning tower and opens the entrance of the air-lock shaft that leads to the sphere. Before he goes down the ladder, however, he points to 2,303-foot Mount Coudon towering over Toulon harbor and says, "We're going down much deeper than that."

Aqualungers Check Safety Locks

Now our Aqualungers prepare to "launch" our curious craft. Clad in black rubber suits, with great black fins on their feet, daggers and lead ballast at their belts, they deploy under the command of a petty officer. Their vital function is to remove the safety dogs which we have bolted over our 7 electromagnets while under tow (page 82 and diagram, page 72).

Flickering down alongside the bathyscaphe, they ceremoniously remove each lock in turn and hand them to Willm on deck to be counted. Not one of these dogs must be forgotten: to press the emergency ballast release, for example, and find it locked could prove disastrous.

I go down the entrance shaft, juggling my cameras, and skin through the narrow hatch to join Houot. Swinging shut the heavy steel door, he tightens the 16 bolts. This is just routine for Houot, but it gives me the odd sensation of condemned men locking themselves in their own cell.

The interior is 6½ feet in diameter and a rather tight fit for us both. My cameras, cases, and lenses cover most of the floor. In front of the conical Plexiglas window I place

the pillow I have brought to rest my knees.

Assuming the posture of a devout Moslem at prayer, I settle happily into this painful crunch, scarcely listening to the faint murmur of the machinery, the hum of instruments. The bathyscaphe is alive—that is all I know. I can hear its heart beat regularly! But I—I am going to see the mysteries for myself, through the green Cyclopean eye of our sphere.

Houot turns the valve of an oxygen container. With a soft hiss the life-giving gas enters our tiny chamber. We breathe it gratefully. Then he pushes controls which flood the air lock down which we have just climbed. This operation subtracts from the bathyscaphe's buoyancy and starts it downward.

From the bridge of the research ship Ortolan is still able to talk with us by radio before our antenna sinks. His clear voice says:

"Depth below you on our echo sounder is 4,050 feet . . ."

The rest of his remarks are cut off. The antenna is under. The bathyscaphe is falling.

I stare through the porthole. Dumas, holding his camera before him, swims past, his Aqualung humped on his back. He is filming the descent of our artificial monster (page 85). Soon we have outdistanced him, however; I imagine him gliding lazily above us, his lens angled down at our dwindling profile.

We have planned to descend as slowly as possible, to let me see everything I can. The blue of the water is the same marvelous color we have seen in Aqualung dives. It changes into deeper blue; the water is clear. I see no fish or plankton.

Houot says, "Three hundred and twenty-eight feet." We have passed the limit of safe Aqualung diving. "I am releasing ballast to lighten ship and slow the descent a little."

I switch on the first droplight. It lights the water at a distance of 10 feet from the

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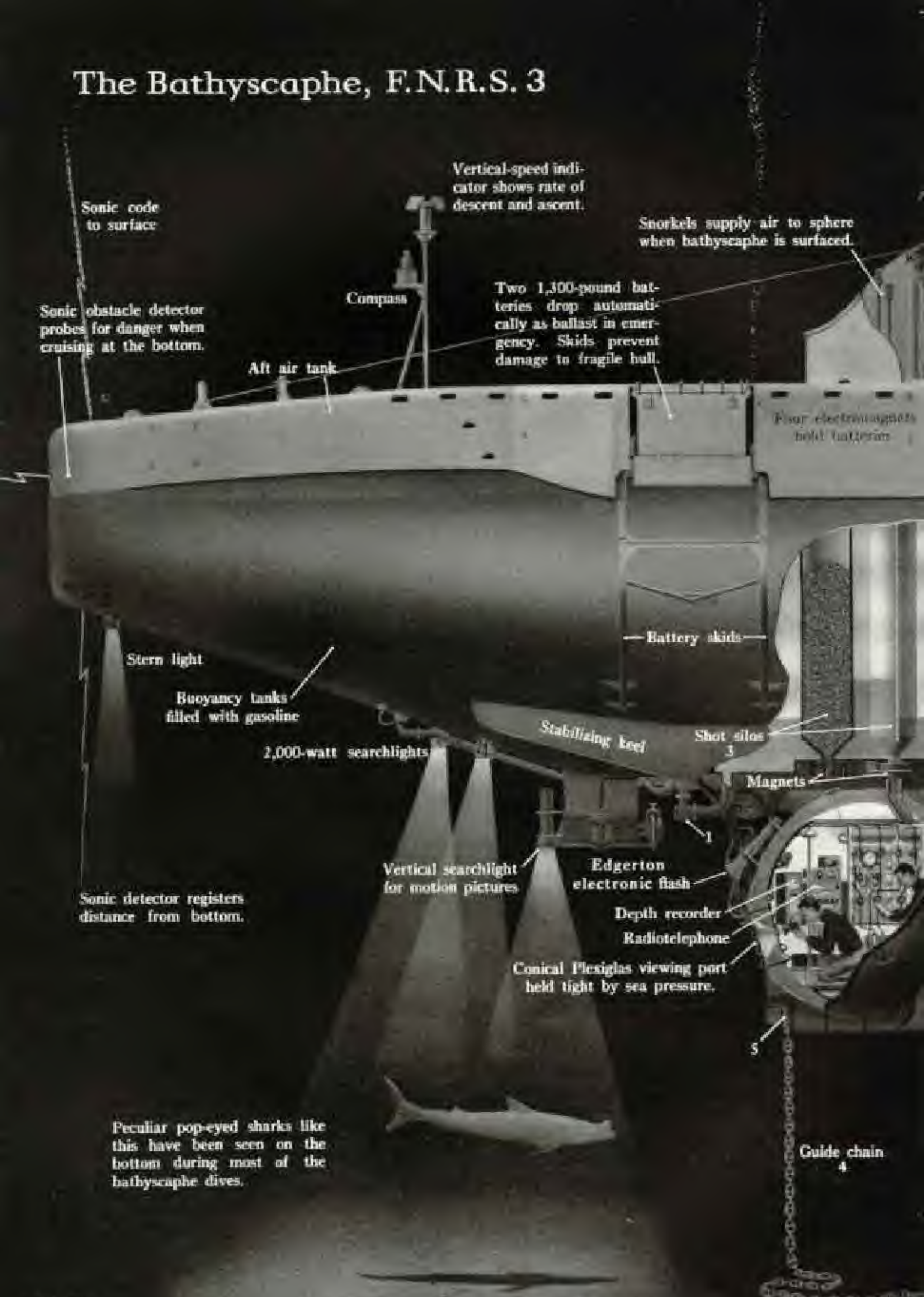
French Navy photo

Brightest of Lamps Can Light Ocean's Gloom a Mere 30 Feet

Dense with millions of microorganisms and far below the reach of the sun, sea water at the ocean's floor acts as a formidable light filter. But lamps suspended on the bathyscaphe's stern far ahead of the camera make photography possible. Seen at a distance as long as the object to be photographed is lighted, the intervening space can be completely dark. Bathyscaphe's builders have proved that it can function safely as an underwater laboratory. Next step: to equip it with a host of specially designed and sensitive instruments for scientists to use in firsthand study of the depths. Here French sailors adjust their Navy's type of electronic flash.

The Bathyscaphe, F.N.R.S. 3



On the surface, the bathyscaphe is towed bow foremost (→) to protect its windowed sphere and electronic equipment. At the ocean floor, its electric motors drive it at one knot in the other direction, permitting its crew to peer ahead through the steel globe's slightly canted porthole. Rudderless, the sub can be maneuvered by reversible twin propellers.

Radiotelephone antenna

Conning tower

Crew enters sphere through air lock, which is flooded to start descent.

Forward and aft air tanks prevent ship's nosing under when towed. As dive begins, sea water displaces the air.

Hand line

Towing bitt

Bow chock

Reversible propellers

Electric motor

Gasoline

Air lock

Stabilizing keel

Bow light

20,000 gallons of light gasoline in buoyancy tanks give bathyscaphe the lift necessary to offset her weight.

Ballast (lead shot) may be dropped in emergency; drops automatically with power failure.

Electromagnetic tripping device

Viewing ports to aid maneuvering

Entrance hatch contains conical plastic porthole.

Free of Surface Ties, the Bathyscaphe Takes Man to New Frontiers in Ocean's Depths

More astonishing even than its record-breaking dive of 13,287 feet is the bathyscaphe's revolutionary design: this fantastic ship operates essentially like an underwater balloon.

From a "gasbag" hull of thin sheet metal hangs a curious gondola—a 12⅜-ton cast-steel sphere. Just as a balloon uses lighter-than-air gas to give it buoyancy aloft, so the bathyscaphe uses lighter-than-water gasoline to give it buoyancy below the surface.

Why doesn't the pressure of the depth crush this fragile hull? Because sea water is free to enter the hull through an opening in the bottom (1) to compensate for loss of the gasoline's volume by compression; thus it exerts the same pressure both inside and outside the hull. Therefore, the hull need be strong enough only to withstand the buffeting of surface waves. However, the sphere's 3½-inch-thick walls are designed to resist water pressures up to 9⅝ tons per square inch, making it possible for the crew to work at sea-level conditions.

To begin the dive, the air lock (2)—the crew's passageway to the sphere—is flooded with sea water. This adds weight to the ship and starts its descent. To slow down, the pilot jettisons driblets of bird-shot ballast from the silos (3) by releasing magnetic controls.

Conversely, as the bathyscaphe encounters cooler and slightly heavier water, its relative weight decreases. The ship slows down and may even stop. To resume the dive, the pilot discharges a bit of gasoline, which is replaced by heavier sea water.

As the bathyscaphe approaches the bottom, the guide chain (4) touches down, and the grounded links lighten the ship so that it hovers in equilibrium. In effect it is "supported" 10 to 15 feet from the ocean floor.

To rise, the entire guide chain is dropped by releasing its electromagnetic fastener (5). After surfacing, the crew uses compressed air to blow water from air lock, thereby clearing the passage to conning tower.

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Harold E. Edgerton

Mystery: Do Myriad Tiny Organisms in the Ocean Cause the "Phantom Bottom"?

Scientists in late years have puzzled over a curious zone, often found from 150 to 250 fathoms deep, that rises by night and sinks by day and reflects sound waves aimed from ships above. Some earlier researchers studying this "deep scattering layer," or DSL, believed it to be caused by an abrupt change in the ocean's salinity or temperature; others now ascribe it to concentrations of fish or squid or to a dense stratum of minute marine creatures (right). Here the author traces the line of echoes picked up by his ship's sounder, as James Dugan follows intently (page 69). After analysis of the DSL by means of such sonic graphs and cameras lowered into the depths, Cousteau grasped at the chance to dive right down through the "phantom bottom."

window. Used for movies, it is strongly overvolted and can be turned on for only 30 seconds before it must be doused to cool. The second light, farther out on the hull, sends a dazzling shaft down into the dark. The third, still farther away, gives a diffused orbit of light out under the stern. Then I turn them all out except number 2.

Four hundred feet down, small glittering particles appear in the beam. At 523 feet we hit the "soup."

"Actually, it's not soup; it's a purée of tiny organisms," I tell Houot excitedly. "Maybe one or two millimeters in diameter. There seem to be billions of them! And yet the water between them is clear.

"Houot, *mon vieux*, I am so thrilled to see at last what Edgerton and I have been photographing blindly all summer! The marvelous part is that these spots let you see the rate of the dive. Try to slow it down a little."

Houot presses a button, cutting a magnet on a ballast silo. Bird shot pours down on the sphere with the cozy murmur of rain on a roof, and our descent slows immediately.

Hanging from the hull above my window is one of Edgerton's electronic flash units, housed in a Pyrex glass tube that has been tested to

withstand the pressure at nearly 5,000 feet.

We have a certain interest in the success of this tube, for, if it were crushed, it might well cripple the *F.N.R.S. 3*. Deep underwater implosions, you see, may be as dangerous as explosions. This Pyrex tube might achieve the interesting distinction of collapsing with a force equal to a small charge of TNT and ripping open the hull, leaving two men almost a mile down in the Mediterranean.

I think of this all the way down. But the tube holds up. Moreover, it flares regularly as I trigger my camera inside the hall.

I have the feeling that I am looking at the Milky Way during a beautiful summer night. Most of the white specks are stationary, but some move in jerks. I cannot determine the percentage of dead and living matter. Seeing some filaments, I suddenly cry:

"Oh, a superb siphonophore, Houot! Not very big. Eight to 10 inches long."

My "secretary" writes it down.

At 850 feet, *F.N.R.S. 3* brakes her own descent, and Houot no longer needs to jettison shot. We hang virtually at a standstill. Apparently, at this level we have encountered a slight but distinct change in water density. This factor is important, for the bathyscaphe is a sensitive densimeter; a small variation in temperature can in effect reduce her total weight by several hundred pounds.

To resume our descent, Houot discharges some of the gasoline in the hull above. Deprived of this lighter-than-water "lift," the bathyscaphe slowly begins to sink once more.

"It looks to me," say I, "as if the specks are bigger. A few minutes ago the mass was fog. Now it is snow—suspended snow that never falls."

Miniature Monsters of the Deep

At 1,200 feet I turn off the searchlight and accustom my eyes to the obscurity. There is still a faint tinge of blue in the water. I can make out shrimps, jellylike blobs, and small medusas, pulsating feebly; and now the first fish appear. Dreadful little things about two inches long, they are covered with scabrous silver patches and have transparent tails and bulbous eyes that start out of their heads. They seem to be *Argyropelecus*. We see these miniature monsters the rest of the way down, together with other varieties, fishes resembling anchovies and small eels.*

In the slow passage from 1,300 to 2,600 feet the animals outside seem pretty much the same, although we have passed beyond the deepest penetration of natural light. But I note that the organisms are growing in size if not in population, without seeming to lessen the transparency of the water.

Without taking my face from the porthole, I squirm to relieve my cramped legs, while Houot tries not to step on me or my photographic equipment. Busy as a bird dog, he keeps my log and his own and yet manages to trim the boat constantly with delicate discharges of shot. Houot can maneuver the 98½-ton bathyscaphe like his own finger.

"You've got to admit," he says, "this ship gives you confidence."

"She's marvelous. But I admire the precision of your maneuvers. From where I am, I feel you are the absolute master of the vertical. Suppose we start the motors."

Cruising a Half Mile Down

"All right," says the master of the bathyscaphe. "Here they go. Do you hear the hum?"

"Yes," I say, "but why aren't we moving?"

Houot chuckles. "What's your hurry? The bathyscaphe is heavy; it takes time to pick up speed."

In a moment I reply, "You're right. We *are* accelerating. It's odd to see all those creatures rushing toward us. It will be even better on the bottom. Okay, let's stop the motors."

The bathyscaphe parades on horizontally for a while, losing momentum. Houot checks the amount of carbon dioxide in the air we are breathing. "Air okay," he reports, and we continue to chat.

"People," I observe, "have told me there is nothing alive in the depths of the sea. But the amount of nitrogen matter I have seen for more than an hour! I am convinced that men will soon begin to 'mine' these vast resources."

Houot nods. "Think of all the experiments that could be made with this device, if it were considered a submerged laboratory . . ."

We sink through the levels reached by William Beebe and Otis Barton in 1934.† At 3,300 feet the density of life increases considerably. I see what appear to be red and

*See "Fishing in the Whirlpool of Charybdis," by Paul A. Zahl, National Geographic Magazine, November, 1933.

†See, in the National Geographic Magazine: "A Half Mile Down," December, 1934, and "Round Trip to Davy Jones's Locker," June, 1931, both by William Beebe.

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Sea's Pressure at 2,500 Feet Crushes a Steel Flash Lamp

Below: Dr. Harold E. Edgerton, choosing damage, decided to house his lamp in a tougher Pyrex glass tube. Above: A flash unit, a stop-motion camera, and a silhouette camera (bottom) developed by Dr. Edgerton with National Geographic Society aid, descend into the sea. The silhouette camera, used for portraying minute organisms, makes a shadowgraph of a disk of water 1 inch thick, 4 inches in diameter. Triggered to shoot when horizontal, it takes pictures every 15 seconds.

white fishes and then realize they are big shrimps kicking their elongated legs. They are about five inches long. Now come smaller shrimps with their long antennae bent at right angles, and a strange, solitary fish, a triangular silvery phantom about 20 inches long.

Suddenly an agitated wake of water ripples across my field of vision. "That was a big one!" I yell. "Maybe a cephalopod."

It goes too fast to be identified. Back comes the wake again, and from the passing blur materializes a beautiful squid, which stops for a fraction of a second as if dazzled by the searchlight beam. Before it vanishes again, I clearly see its rocketlike head and its 10 arms. It is about 1½ feet long, and it leaves a blob of ink. The ink is white.

Now, it is well known that octopuses and squids of shallow waters discharge dark-brown ink. I switch off the searchlight. The squid ink glows phosphorescently in the dark. As I stare at this apparition, another squid jets luminous ink in front of the porthole.

My excited description of these events does not impress the pilot. "Let me have a look," says Houot, skeptically. The next squid makes a believer out of him. It lays a white cloud that practically blots out the window. He surrenders the observation post to me again.

We are approaching the bottom. I peer down intently to where our shaft of light fades into the obscurity of the unknown.

"Four thousand feet," says Houot.

My heart beats rapidly then, for I discern, down below, a faint milky glow—our droplight reflecting from the floor of the sea. For the first time, our bathyscaphe is about to *land*.

Harold E. Edgerton and
James Vine Cleaveland

Deep-diving Cameras Record Teeming Life Far Below Surface

To Cousteau, all past efforts to photograph the sea's inhabitants resemble those of a bullcalf lowering a camera through the earth's cloud cover and shooting pictures at random. Such a census taker would be lucky to develop, on one print out of 5,000, the image of some passing bird or animal.

The ocean's habitable area is many times that of man's estate; yet the bathyscaphe's first tentative explorations have revealed even at great depths a startling richness of marine life, from a thick, unreaping "soup" of microorganisms to groups of sharks, crabs, squids, and shrimps.

The thin, wirelike creature above has never been identified; apparently it swims too fast to be netted. Odd streamered siphonophore at right, posing for its first picture undersea, is a cluster of dozens of marine animals.

Six-foot shark (below) with white protruding eyes is first ever photographed below 2,000 feet. In complete darkness at such depths, fish apparently use their eyes only to pick up the phosphorescent glow of their prey.

Now I see the bottom, clear and bare. The guide chain dangling below our car touches the ground and relieves just enough weight to bring our fall to a stop. No vibration. *F.N.R.S. 3* is trimmed neatly 10 feet above the sea floor, 4,040 feet down.

I shout, "A shark!"

Houot laughs and says something about nitrogen narcosis, the intoxication of the depths. "Another shark!" I cry.

"Your case seems serious," the pilot observes. I pull him down to look over my shoulder. He sees a charming little shark about three feet long. It comes on until its nose almost touches the Plexiglas. It seems to want a good look at us. Now it slowly swims away, its curiosity satisfied.

Larger sharks, 8 to 10 feet long, swim through the arena of light. Unlike their familiar cousins in the heights of the sea, they have broad, flat heads, elongated like a snout, and big, protruding white eyes which glisten in the searchlight's beams. Lazily they turn in the glowing circle, throwing shadows larger than themselves on the pale mud.

I remember now where I have seen one of these creatures before; it was at a country fair, billed as a "caterpillar of the sea," a weird monster from the great depths.

What are its eyes for, I ask myself? No daylight penetrates into this absolute darkness. The shark must use its eyes simply to detect the phosphorescence of its prey.

I break off my speculations, for suddenly I see something so startling I burst out laughing. A newspaper lies spread on the sea bottom.

Sharks Still Prowl Around Sphere

We decide to rest the sphere on the mud by valving a little gasoline. We know the theory of this technique, but we have never actually done it in the depths. When Houot turns the valve, we almost wince: gasoline is precious, and this is like losing one's blood.

We sink the last 10 feet more to land without a jolt, throwing up a light mud cloud. Now my porthole, slanting diagonally, is three feet from the bottom of the Toulon canyon. The clear yellowish sand, or mud, is blistered with innumerable big mounds pierced by small holes like those of marmots. Animals are burrowing into the bottom, indicating an intense underground life. Shrimps four or five inches long float by.

We are in no hurry. We plan to stay on the bottom for four hours while I experiment with movie and still pictures. Before starting the motors to make a journey across the floor, we intend to look at the landscape and discuss it for a while. Outside, the fantastic weaving dance of the sharks continues. There are as many as four in sight at once, casting huge baroque shadows on the sand.

"Soup" Grows Thicker with Depth

Houot and I agree that bathyscaphe dives upset some traditional ideas of the sea. For us, at least, the problem of the deep scattering layer is now restated in entirely new terms. So far as we can see, there is, biologically speaking, no DSL, but rather a great bowl of living soup extending on down and *growing thicker the deeper into the "tureen" we go.* Both Beebe and Barton, the two men who have previously looked out into the deeps, have reported that the density of organisms seems to increase with depth; but so far little attention has been paid to their statement.

The cycle of marine animal life is supposed to depend directly or indirectly on phytoplankton, generally microscopic algae that live in suspension in the water. These basic plants of the undersea economy rely on photosynthesis, the process by which those containing chlorophyll use energy derived from sunlight to make carbohydrates. This activity can take place only in the layer penetrated by sunlight, usually to a depth of 600 feet; often not more than 200 feet.

Below this life-giving realm of the sun, says classic theory, the animal population thins out in the dark and the cold, where living creatures are supposed to depend on the plant life at the top, in a vastly complicated web of existence. Yet against this notion are ranged the direct observation of five men who have been to the depths—Beebe, Barton, Houot, Willm, and myself. I cannot propose an explanation of why reality does not match the simple, attractive theory. But there must be somewhere an unsuspected link in the cycle of marine life yet to be discovered.

We decide to cruise along the bottom. Houot presses a lever to discharge some ballast. Instantly we hear the rumbling noise of something heavy falling from the ship.

We look at each other. Says Houot: "The guide chain must have fallen."

I am still at the porthole. "No. The outside lights have gone out. The batteries must have dropped off." A very short silence.

The pressure gauge is just above my head.

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Paris Match

Up Safely from a Dive, Bathyscaphe Bobs Homeward Under Tow to Distant Toulon

With bell-shaped air tanks above the waterline to prevent nosing under, and with stabilizing keels below to check her rolling, the French "deep-boat" has proved exceptionally seaworthy. On the ocean's floor her only fault was a tendency to blow a fuse, demagnetizing all locks and dropping emergency ballast. When this happened to Cousteau, he glanced at the depth gauge; for a few seconds it showed no movement, suggesting that the bathyscaphe was trapped. Then, slowly, the needle crept upward. Said Cousteau later: "Such moments have a particular flavor that I cannot explain."

The hand does not move. I rap on the gauge.

"Listen, Houot. With our ballast gone, we should be going up; but the pressure gauge says we're still on the bottom."

It is a puzzling, fearful instant. We survey the situation. The lights are still on in the sphere; they work from their own power plant. But the outside lights are gone. I cannot see the bottom in the sudden darkness, so I am unable to tell whether we are rising or remaining at a standstill. Yet we certainly must have dropped all ballast.

Apparently, when Houot pressed the ballast discharge button, his action created a slight overload on the electric circuits. A fuse blew, and the bathyscaphe automatically released two silos and two cases of shot, two huge batteries and the guide chain. We should be climbing at top speed, but, according to the pressure gauge, we are not.

"What about the vertical-speed indicator?" Houot reminds me.

We look at its dial.

"Right up to the maximum," he says. "We *are* rising!"

The darkness outside gives no confirmation. We can feel no motion. We turn back to the pressure gauge. Slowly its needle begins to swing. The two gauges are now in agreement; we are headed for the surface. The pressure index was just slow to respond.

With a shrug, Houot opens Willm's brief case and gets out sandwiches. We go up so fast, however, that we scarcely have time to eat.

Diligently Houot taps out the Morse code signal warning our little fleet above that we are coming up and to clear the area to avoid collision. For myself, I am full of thanks for the merciful design of this craft of ours, which so obligingly hurries toward the top the moment anything goes wrong.

At the surface we find the sea choppy, but the sun was never so bright.

Thus ended our last dive before the bathyscaphe's departure for Dakar, French West Africa. There, in water far deeper than in our Mediterranean descent, Houot and Willm were to attempt the record-making dive described in the following pages.

Two and a Half Miles Down

Even at the Greatest Depth in the Sea Ever Reached by Living Man the Bathyscaphe's Crew Finds Abundant Signs of Life

By Lt. Comdr. Georges S. Houot

OLD residents of Dakar said, "The best weather for your big dive will be just before the full moon."

The almanac showed the February full moon of 1954 was due on the 17th. As the day neared, the meteorological forecasts swung into agreement with the local sages, and at dawn on the 15th we began to load the bathyscaphe with shot ballast.

A few hours later the Navy tug *Tenace* took her in tow, and, with the sun breaking cheerfully through the overcast, we headed out into the swells of the eastern Atlantic. All night and well into the next day we steamed along at our 4-knot towing speed, the submarine following easily and without incident.

Some 160 miles southwest of Dakar we neared our diving site. Soundings showed a depth of about 13,300 feet; the echoes were clear, and the bottom appeared smooth and level, favorable for our "landing."

Pilotless Dive Proves Sub's Ability

None of us got much sleep the night before the dive. My brain worked over the precautions, the unforeseen elements, the fantastic anticipation itself. I comforted myself with the reflection that at least this operation seemed to be going better than the pilotless 13,450-foot dive on January 27.

That affair had been a hard trial indeed of the bathyscaphe and the men who handled her. The waves had been 12 feet high. The tow cable had parted, casting the *F.N.R.S. 3* adrift, and we had had to scatter the convoy to avoid collisions in the darkness. All night the *Elie-Monnier* had kept the submarine in her searchlight beam. In the morning, two parties of seamen and a diver had to struggle for hours on the pitching bathyscaphe before they could pass a new towline.

Even so, that pilotless dive had been a success. When a Navy flying boat radioed, "Bathyscaphe on surface, 15:05," we knew we had witnessed a historic day in the annals of undersea exploration. For the dive had proved that the bathyscaphe met specifications.

Our aim had always been to create a vehicle capable of descending repeatedly to 13,125 feet (4,000 meters), slightly more than the average depth of the oceans. Now all that remained was for Lt. Pierre Henri Willm and me to go there ourselves.

Everyone turned out early. In the first light of the winter day, February 15, 1954, our little ships gathered around the tiny submarine in the heaving ocean. Willm and I put on heavy pullovers; it would be cold down there. To this costume Willm added a brief case, making him look like a serious young lawyer on his way to the office. The brief case, however, contained sandwiches.

At 7:40 he and I went over the side to a dinghy with Midshipman André Michaudon. Not trying to hide the worry on their faces, Lt. Comdr. Georges Ortolan of the *Elie-Monnier* and Comdr. Philippe Tailliez of the Undersea Research Group said goodbye.

We crossed the waves to the bathyscaphe, and Willm leaped aboard her. Disappearing down the air lock, he unbolted the entrance hatch to the sphere, closed while under tow. From the conning tower I directed the lowering of the guide chain, while a quartermaster and two divers swam under the "deep-boat" and removed the security dogs from the electromagnets.

They found, unfortunately, that one of the dogs had been insecurely fastened, jarring loose the electromagnet on a shot silo. We had no way of replacing the magnet without breaking the electric circuit, interrupting the magnetic field that bars the shot from falling and emptying the silo of its pellets.

Houot Jettisons a Ton of Ballast

For a moment it looked as if this mishap had canceled our dive. Then Willm reminded me that he had put aboard the *Elie-Monnier* an extra ton of shot before leaving Dakar. His lucky inspiration saved the day. We jettisoned the silo's contents into the sea and refilled the tube with 20 bags of shot, paddling them over to the bathyscaphe in two rubber dinghies. It was hard work, but the men were full of ardor and good will. They finished a few minutes before 10.

We said goodbye to Michaudon, who was to add the final pounds of shot, then hurried down the ladder of the air lock and bolted our-

Engineer Stations ➔ Himself at Sub's 4-inch Cyclopean Eye

Above Lt. Pierre Henri Willm's head, a pressure gauge registers zero, indicating that the ship is at surface. Enclosed graph (left) records signals from the echo sounder. Top right are the ultrasound transmitter and receiver; below, the radio set, for use only above water. Rubber pipe connects with snorkel breathing system. Telephone enables pilot in sphere to talk with launching crew up in the conning tower.

Lower: His legs tucked through a side hatch at the air lock's bottom, Houot wriggles into the sub's spherical gondola. Sea water admitted to this air lock later will add weight and start the dive.

selves in the steel ball. By telephone we told Michaudon in the conning tower to open the sea cocks of the air tanks, release the towline, and get off on the dinghy.

From now on, no one could help us. We were the masters of our fate.

To start the dive, we turned the valve flooding the air lock. From the *Elie-Monnier* Ortolan's voice came over our loudspeaker: "The bathtub is halfway under. The base of your antenna is covered. So long and good. . . ."

We heard no more. The antenna was drowned at 10:08.

Once again we relived the stirring minutes of passing through the photosynthetic zone (page 78), sinking into the blue sea—the blue that deepens and grows dark. Softly, softly we were falling into a hostile world where men can live only in a globe of steel.

Our dive plan called for a swift passage through the first 6,600 feet. We wanted to spend the time we saved on the virgin depths below. The hands of the pressure gauges turned slowly while we worked feverishly to arm the cameras.

Mounted on the outside was a new "3-mile" electronic flash unit built by Dr. Harold E. Edgerton for the National Geographic Society. We called it the 3-mile flash because it could withstand the pressure of that depth without crushing. With this margin of safety we need think no longer of an implosion destroying the bathyscaphe (page 75).

Fish Man Circles Sub to Check Safety "Dogs"

Before each descent, a launching team of Aqua-langers removes the locks that secure the bathyscaphe's electromagnets while under tow. The crew double-checks the count, for even one magnet, left fastened and incapable of dropping its ballast, could spell death to those trapped in the sphere.

←Cylindrical electromagnet controls release of the guide chain. When current shuts off, a system of levers lets the cable fall free.

At 11 we had attained 3,280 feet, with everything going smoothly, almost noiselessly, when the stuffing box on a pressure gauge gave way slightly, leaking tiny drops of oil onto Willm's neck as he crouched at the porthole. He looked up at once, for we were going to a level where the pressure, four times greater, might cause a gusher of oil to spurt from that gauge. Picking up a huge monkey wrench, Willm tried to tighten the nut. In our clutter of instruments, clothing, snacks, extra gear, and ourselves, it was difficult to swing the wrench, but we got the leak stopped.

Our descent continued at greater speed, about 100 feet per minute. Outside we now observed small jellyfishes among the trailing siphonophores. The "soup" was thick. The comparison with a starlit night, in fact, was never more striking.

At 11:30 our pressure gauges read 6,560 feet: we were passing through the lowest strata we had reached in the Mediterranean

dive last August. Willm pressed the button which cut off the electromagnets on our four silos and held it down for 100 seconds. A ton of iron pellets fell on the sphere and bounced into the sea, greatly reducing our speed. I tapped out an ultrasound message to the ship far above:

"Everything going well; 6,560 feet."

Now the vertical speed indicator stood almost at zero. We were inching through the black unknown, with a circus outside the window. In the bright light, magnificent red shrimps with long antennae swam past.

By noon we had reached 9,845 feet, close to the greatest depth hitherto attained—by Prof. Auguste Piccard in his *Trieste* bathyscaphe on September 30, 1953. Releasing another ton of ballast, we stopped almost dead.

Every square inch of the sphere was now being subjected to a load of 4,370 pounds. Carefully we inspected our weakest points—the outlets through which control cables pass outside to the lights, motors, and electromagnets. We had sealed these small holes with conical plastic washers, so designed that the pressure of the water against the sphere should make them tighter than ever. Was the theory sound?

Though our ears strained for suspicious noises, we heard only the normal hum of the transformers, the hiss of the oxygen, the regular tickrock of the clockwork in the pressure recorder. "All control apparatus functions perfectly," I wrote in the ship's log.

Releasing some of our buoyant gasoline, we started downward once more. As we encountered increasing pressure, our remaining gasoline slowly contracted, and sea water filled the space in the bottom of the buoyancy "balloon." Heavier now, our ship picked up speed.

Sea's Pressure Squeezes Steel Sphere

Willm said, "It's about time we heard the duralumin frames cracking. In this pressure the sphere should contract about one millimeter [.04 inch] and pull a bit on the support frames."

But we heard nothing. The frames proved sufficiently elastic to adjust to the shrinkage of the ball.

At 12:45 our pressure gauges registered 11,800 feet. I started the echo sounder. At once the stylus started drawing pictures of the sea bottom. On the graph the depth profile sloped up toward us. It gave us a rather queer feeling, for on a moving ship, when one sees the graph climbing, it means a hill rising from the floor. Our "hill" was caused by the submarine falling toward a level plain.

When we reached 660 feet "altitude," it was time to decelerate. We didn't know whether the bottom was smooth or jagged, and the bathyscaphe must land very lightly.

Systematically we shed ballast—first 550 pounds of shot, then 330 pounds, until the *F.N.R.S. 3* had a negative buoyancy of only a few pounds. With our craft so nearly in balance, we could rise by dropping only the guide chain.

Preparing to Land on the Bottom

Slowly the curve of the echo graph climbed toward us: 330 feet . . . 200 feet . . . 165 feet . . . 65 feet. The soup outside seemed motionless. Only the echo sounder and the log acknowledged the descent. We were more than 2½ miles down.

I was at the porthole in the profound silence of those last moments. Finally—

"I see the bottom!"

It was thrilling. Our droplights made a theatrical circle about 10 feet in diameter on the sea floor. The yellow sand was carved in low ripples. Everywhere extended mounds with animal holes about an inch wide. Though we never saw a creature go in or out of the holes, we felt there must be many living things under this rumpled surface.

The guide chain touched bottom, and the *F.N.R.S. 3* came to a dead stop, hanging above the floor by a steel tendril. There were no more maneuvers to be made. The water temperature was 41° Fahrenheit, and the inside of the ball was very cold to the touch.

I checked the temperature gauge of the gasoline in our "balloon": 50° F. Soon, as the gas cooled, contracted, and became heavier, the sub sank gently to the bottom. A cloud of very fine sand bloomed around the gondola and drifted away in a slight current.

We had landed at 1:30. Above us, 13 Eiffel Towers could have been stacked on end without reaching daylight. We were alive inside a 3½-inch shell, withstanding a total pressure of 68,000 tons, or 5,900 pounds per square inch.

We took turns at the porthole, staring at the sea floor at a depth no man had ever reached before alive. Beautiful colonies of sea anemones were clinging to the bottom. Tulips of crystal, they swayed lightly in the gentle current.

Willm took over the porthole. In a moment he shouted, "A shark!"

It is a cry that should become frequent among men who go to these depths. It would be odd to parachute aimlessly into mid-Sahara and land beside a lion; yet each time we have visited the bottom wastes in the bathyscaphe we have seen at least one shark. Unless our luck has been phenomenal, this must mean there are thousands of them living in the world's dark basement.

Willm's fish was about 6½ feet long. Though it must have known nothing but everlasting darkness, it swam without hesitation into the glare of our lights and looked at the porthole with its great protruding eyes. The long body undulated lazily in the droplight.

Our dive plan had provided for three hours on the bottom. In no hurry, we amused ourselves by nudging the bathyscaphe here and there with the electric motors, extending our vision. Our only concern was to surface before nightfall, so that the little submarine could be taken under tow in daylight. The air seemed fresh and tonic, and we thought ourselves the kings of the sea.

It was 2:06 when our elated trance was broken. A tremor shook the bathyscaphe. Remembering past accidents, we realized at once that one of the magnets above us must have failed and that a 1,300-pound battery was loose. A second quake followed as the remaining magnets cut out, and a dull rumble told us the batteries were skidding off and crashing into the sand. The exterior lights went out.

After only 56 minutes in our new realm, we were helplessly soaring to the surface at top speed, about two miles an hour.

I took the ultrasound key and tapped out dash-dash. On the *Elie-Monnier* they read our disappointment in the single code letter "M," which meant *Je monte*—"I ascend." (We didn't have a letter standing for "Blast it all, anyhow!") "M" meant that the escorts and tenders were to scatter to avoid the risk of *F.N.R.S. 3* crashing against a keel.

At 15:21, 75 minutes after our batteries had fallen, we broke the surface, 1,100 yards from the *Elie-Monnier*. As soon as the antenna was out of the water, I phoned Ortolan:

"We have been half an hour on the bottom at 13,287 feet."

He replied, "We picked up your signals. Congratulations, old man!"

Rear Adm. Jean Georges Gayral, commanding the Navy in French West Africa, buzzed us in his flying boat, sending us his felicitations by radiotelephone.

We blew the water from the air lock and climbed through the hatch. A blast of cold, wet sea air swept down the lock to greet us. After staggering up the ladder to the conning tower, we stood blinking in the sun, our eyes dazzled after so long below.

The first man aboard was Midshipman

Houot, Clutching Lines, Races for Conning Tower Before the Big Dakar Dive

A test the previous month had proved the bathyscaphe's ability to plunge, unmanned, to more than 13,000 feet. Houot and his brilliant engineer, Willm, then sought to show that men could safely accompany her to these depths and explore the mysteries of the true ocean floor.

Pierre Yale, Paris Match

Leaving Diver Behind, Sub Plunges Toward Sea's Dark Kingdom

Camera in hand, Cousteau's friend Frédéric Dumas swims down beside the descending bathyscaphe until she sinks past the 40-fathom zone, limit of the skilled Aqualunger's normal range. From the conning tower bubble the last pockets of air trapped in the air lock (page 71).

French Navy, Official

Michaudon, grinning broadly. I am afraid he heard no historic utterances. I asked him something practical, which I no longer remember. He turned to Willm. The engineer said: "Oof!"

Throughout the French Union, however, from Indochina to the islands of St. Pierre and Miquelon, the victory signal chattered on the keys of the fleet. Aboard the *Calypso* in the Persian Gulf the radioman posted a bulletin headed, "Gloire à la Marine Nationale!"

We had set a record: but that was only incidental to our true purpose—to prove that the *F.N.R.S. 3* could attain the depth which she was designed to reach and explore.

Well, she can and she will. From now on, the bathyscaphe

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Photo Ets. Paul Maye

Their Chariot a Dinghy, Houot and Willm (Center) Return in Smiling Triumph

First to reach and cruise along the Atlantic's floor beyond the Continental Shelf, the famed bathyscaphe pair regretted only the brevity of their plunge (page 84). Tug stands by to tow bathyscaphe back to Dakar

belongs to science. In Paris, we knew, a committee was already weighing research projects submitted by Belgian and French scientists eager to go below. A worthy use for our little ship, but sad news for Willm: under such a plan he will have to surrender his berth to a succession of savants.

The *F.N.R.S. 3* will go no deeper than we have taken her; that is her habitat. But her adventures on the ocean floor have only begun. What mysteries of marine life will she yet probe? What relics of our ancient past —buried wrecks, encrusted marbles, sunken cities—may she not stumble upon? What curious new creatures will she perhaps discover in the vast, unknown continents that lie beneath our salty wastes?

We know not. But for ourselves, for Willm and me, the strongest lure the future holds is the building and testing of the abyssal bathyscaphe. Prompted by the scientists, we shall continue to modify and improve the present machine, learning to equip her with new tools, new antennae to extend our senses into this dark, watery world. But always we shall be looking beyond to her eventual successor, the ship that we shall someday launch and take down to the 35,640-foot Challenger Depth, between the Caroline Islands and Guam, the profoundest known deep in all the oceans lapping our globe.*

*The authors of the two foregoing articles wish to acknowledge the assistance of Lt. Pierre Henri Willm and of Mr. James Dugan, an aide of Captain Cousteau on the National Geographic Society–*Calypso* Oceanographic Expeditions.

New Miracles of the Telephone Age

Communications Have Just Taken One Forward Step by Adding Sight to Sound. Now the Future Promises Even More Startling Changes

By Robert Leslie Conly

National Geographic Magazine Staff

THE physicist tossed a shiny object smaller than a pea onto the desk in front of me.

"There it is," he said. "There's your miracle. Doesn't look like much, does it?"

I picked it up in my fingers. It was a tiny speck of silvery-gray metal, coated in plastic. Three wires thin as cat whiskers led out of it. That was all (page 89).

This was the transistor, invented by scientists in the building where I was sitting, the Bell Telephone Laboratories, at Murray Hill, New Jersey. It is the "electronic midget" that makes cautious physicists and sober businessmen talk like science fiction writers.

Basically, it is a device for controlling the movement of electrons, tiny negatively charged particles of electricity. It can do the job up to a million times more efficiently than its predecessor, the vacuum tube.

Someday, radio engineers prophesy, houses will be transistorized. Mothers will watch their children playing in the yard, their babies sleeping in the nursery, their cakes baking in the oven, just by flipping a switch. A television screen on the kitchen wall or in the living room will pick up any part of the house through miniature, inexpensive transistor cameras.

Transistor "Brain" May Steer Your Car

Automobiles, too, will be controlled by transistors. When the family takes a trip, it will climb into the car, set the controls, and relax while a transistor brain under the hood takes over the driving, guided by radio waves from transistor circuits under the highways.

Dr. Harold S. Osborne, who retired not long ago as chief engineer of the American Telephone and Telegraph Company, makes an even more startling prediction:

"Let us say that in the ultimate, whenever a baby is born anywhere in the world, he is given at birth a number which will be his telephone number for life. As soon as he can talk, he is given a watchlike device with 10 little buttons on one side and a screen on the other.

"Thus equipped, at any time when he wishes to talk with anyone in the world, he will pull out the device and punch on the keys the number of his friend. Then, turning the device over, he will hear the voice of his friend and see his face on the screen, in color and in three dimensions. If he does not see him and hear him, he will know that the friend is dead."

How far away is this transistorized tomorrow?

Perhaps not so far as you think. Mass production of transistors is just beginning in 1954. "Closed circuit" television systems like the one the housewife may use to watch her children are operating today in industry, with cameras overseeing production lines and even peering into blast furnaces. Miniature electronically controlled automobiles have been built and operated.

Telephone Changed Civilization

Fantastic as it is, the promise of the transistor is only part of a bigger change in our civilization that started in 1876, when Alexander Graham Bell invented the telephone.

From the telephone laboratories that grew out of Bell's workshop, scientists have continued to pour out an astounding array of inventions, ideas, and machines. All have been designed for the same purpose: to make it easier for people to communicate over distances.*

Today there are 51,000,000 telephones in the United States, roughly one for every three people. This is 57 percent of all the telephones in the world. Americans use them 188,000,000 times a day, 365 days a year.

But the change did not stop there. After World War II, television burst on the United States like an explosion. In 1946, practically speaking, there wasn't any. By 1954, eight years later, more than 60 percent of all

* See, in the National Geographic Magazine: "Miracle Men of the Telephone," March, 1947, "The Miracle of Talking by Telephone," October, 1937, both by F. Barrows Colton; and "Prehistoric Telephone Days," by Alexander Graham Bell, March, 1922, the only biographical article ever written by Dr. Bell.

American homes had one or more television sets. Nearly 400 television stations were broadcasting programs in more than 225 cities.

Popular weekly TV programs could—and did—boast of regular audiences larger than 40,000,000 people. Surveys indicated that the average member of a "television family" spent roughly 2½ hours a day watching his screen. As one network official pointed out, this probably makes watching television the third largest activity in American life, exceeded only by sleeping and working.

Seeing by Telephone

And though many in the audience may not have realized it, whenever they watched a network television program they were seeing by telephone. For it is the Bell Telephone System—the A. T. & T. and 21 associated companies—which provides the broad communication highways that carry television's moving, talking pictures from city to city and from coast to coast.

To handle television transmission and to serve the millions of telephones—half of them added in the last decade—the Bell System has undergone since the war the biggest expansion of any corporation in the history of this country. Expenditure for new telephone facilities alone amounted to nine billion dollars.

Most of this tremendous sum came not from company revenues, which are closely regulated by Federal and State governments, but from the public. Six times since 1945 A. T. & T. has gone to investors, including its own stockholders, for money. Each time they responded by investing amounts ranging from $343,000,000 to more than $600,000,000.

The latest issue of convertible debentures, offered in 1953, was for $602,000,000. Significantly, the majority of subscriptions came from existing stockholders. Yet during the last eight years the number of shareholders in the A. T. & T. has grown from 684,000 to 1,265,000. No other private company has so many.

This telephone expansion presented a truly staggering problem to the company's engineers. Thousands of miles of coaxial cable, lead-sheathed copper tubing as thick as your arm, were plowed underground, and costly electronic "repeater stations" installed every few miles along the way to service it. New telephone exchanges were rushed to completion. The number of telephone operators grew past 200,000 by 1950 and kept on growing. But the demand was still too great.

Finally Bell scientists and engineers had to design and build a brand-new kind of communications system.

First, they devised one of the most amazing machines ever put together: an electromechanical brain that can handle not only local but long-distance telephone calls automatically, without help from an operator.

Second, they built a transmission system which does not use cables at all: the microwave radio relay.

Today, when you telephone from coast to coast, there is a good chance that your voice travels most of the way through the air, by radio waves. As it flies, it is very probably sandwiched in, along with several hundred other voices, between two television programs. The two TV programs take up as much channel space as 600 two-way phone conversations.

If you have driven recently on the open highway in mountainous terrain, you may have noticed, high on a peak, one of the steel or concrete towers of the microwave relay system. It probably looked like a lighthouse with a cluster of giant megaphones on top. The "megaphones" are the all-important antennas that transmit the radio signals.

107 Towers Span U. S.

There are 107 of these microwave relay towers now stretching across the continent like a huge, loose-jointed picket fence. In addition to this central relay line, which runs from New York to San Francisco, other lines carry signals north and south to other sections of the country. Altogether, there are more than 400 towers in the United States.

The towers are usually about 30 miles apart, but always within line of sight of one another. For microwaves, unlike some other radio waves, will not "bend" effectively around the earth's curvature.

To find out how the microwave relay system works and to see a relay tower in operation, I flew to Reno, Nevada. Fifteen miles southwest of Reno in the High Sierra stands 10,778-foot Mount Rose. Near its peak the telephone engineers built, in 1950-51, the highest relay station in the country.

The bill for construction and equipment on this one station came to more than $700,000. Just building a road up the mountain cost A. T. & T. $120,000.

The last 1,500 feet to the summit is a

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Transistor, Electronics' Wonder Tool, Needs a Magnifying Glass for Assembly

The tiny transistor, unveiled by Bell Telephone Laboratories, Inc. in 1948, eventually may replace vacuum tubes in most electronic equipment including radios, TV sets, computers, guided missiles, and robot brains. Unlike space-consuming vacuum tubes, the transistor requires no fragile glass walls and no vacuum. Its crystal of germanium or silicon works in a more crumy. With as little as one-millionth of the power needed by the vacuum tube it can control the movement of electrons in an electric current. Here a technician, seen through a transparent work bench, uses forceps as she checks contacts in a transistor. In 1954 the device is scarce and expensive, but engineers predict mass production in two or three years (pages 93 and 133).

jagged, 45-degree grade. For an all-weather approach up this grade to the peak, the Bell engineers constructed a powerful aerial tramway. The relay station itself is built of heavy concrete to stand against 150-mile winds and 50-foot snowdrifts.

When I went up Mount Rose, the weather was quiet and sunny; only a few shaded mountaintop crevasses showed patches of snow. I set out from Reno with three telephone men, John Ostrom, Bill Doyle, and Jerry Miller, all of whom had helped build the relay station and now share in the job of running it.

It's no easy job. A maintenance man at Mount Rose must be a combination of technician and frontiersman. He must know how to couple a superhigh-frequency wave guide, fix a gasoline engine, and use skis and snowshoes expertly.

Near the base of the mountain Ostrom

Kodachrome by National Geographic Photographer J. Baylor Roberts

Telephone Magic Shoots Live Action from This TV Stage to 6,000,000 Homes

Joan Caulfield (behind sofa) and Barry Nelson (on sofa) act out "My Favorite Husband" before wheeled cameras at CBS's ultramodern Television City in Hollywood. Within 1/50 of a second their images will flash on screens in homes throughout the country. The stage-lighting expert (left) plays his battery of lights from an organlike console. All-electronic, the board can "remember" a complicated series of lighting changes set up before the performance. Monitor TV screens show the operator the results of his work; others, hanging from the ceiling, show the studio audience the same scene carried by Bell System facilities to viewers in 43 cities.

turned the car off the road in front of a big red barn.

"Come on in," he said. "I want you to see the Sno-Cats." These odd gas-driven vehicles resemble a seaplane, an army tank, and a Toonerville Trolley, all rolled into one. The Sno-Cat's cabin, high and square, rests on four pontoons, each ringed with its own caterpillar tread (page 102).

"When the snow comes," Ostrom said, "we ride these up the mountain. Six feet of snow or 60 make no difference to them."*

"When it gets deep, we're often the only ones who get through. We run a regular delivery service for people living along the road. They phone us down in Reno and say, 'You're coming anyway, so would you mind bringing some aspirin?' Once we took a load of hay to feed some starving cattle. Another time we carried two pregnant women down from the hills to the hospital."

Back in the car, we drove on to the bottom of the aerial tramway. Here, when the weather is bad, they park the Sno-Cats.

"You ought to try this in a blizzard," said Doyle as we climbed into the gently rocking tramcar. "You can't see the ground below; in fact, you can't see anything more than 18 inches away. You just sit in the middle of nothing and hope she keeps moving."

At the top of the tramway, Doyle unlocked the heavy metal door of the relay tower and we entered.

Bunks for 10—Just in Case

I found myself in a comfortable living room. Through a door I could see a kitchen with an electric stove, a refrigerator, and a big food freezer (page 105). There were beds, and even a bathroom with a shower.

"Normally," Ostrom explained, "this station is unattended, except for a monthly routine check. It does its job automatically, like most of the other relay stations. But when any of the equipment here breaks down, we have to climb the mountain and repair it.

"In this country, you never know when you'll get down again. Several of us have been trapped up here by blizzards—sometimes just overnight, sometimes for a week. So we always keep enough food on hand to last a month. We have bunks and bedding enough to sleep 10 men, and an automatic oil furnace."

Adjoining the living quarters, a large room contains the electronic equipment needed to run the station. Steel cabinets hold a complexity of wires and banks of tiny vacuum tubes. These are the amplifiers and modulators that control the strength and frequency of the radio signals. Wave guides, square metal pipes of precise dimensions, lead from the amplifiers to the antennas on the roof.

The function of the relay station at Mount Rose (and at all the other stations in the chain) is simply to pick up radio waves from one relay station 30 miles away, boost their power, and send them on to the next relay station 30 miles in the opposite direction.

The waves may be carrying television programs, telephone calls, radio programs, or all of these things at the same time.

How a Microwave Relay Works

Four hornlike antennas on the roof of Mount Rose station work together in pairs, one of each pair aiming west, one east; one receiving, one sending. Between them the two pairs can provide six broad communication channels in each direction. Each channel can transmit a television program or hundreds of telephone calls at once. One serves as a reserve channel for use in emergencies.

To understand how the microwave relay system operates, consider a television program being produced in New York. Suppose it is a weekly, hour-long dramatic show, which costs $75,000 to produce and put on the air (some run considerably higher than this). An advertiser is paying the bill; to justify spending so much money, he must reach an audience of millions. So he wants his program not just on one station, but on a network.

A sponsor may "buy" a network of almost any size, from a few stations up to more than 100. Suppose, since our program is an expensive one, he chooses a 64-station coast-to-coast hookup. In this case, approximately $1,800 of his $75,000 goes to the A. T. & T. for transmission. The rest is paid to writers, actors, directors, and musicians, and to the network and its affiliated stations.

As our program goes on the air from the New York studio, three or four television cameras are trained on the stage from different angles. The cameras are mounted on wheels so they can move with the action.

Each camera "sees" the stage through lenses, just as a photographic camera does.

* See "Sno-Cats Mechanize Oregon Snow Survey," by Andrew H. Brown, National Geographic Magazine, November, 1949.

Tomorrow's Picnickers May Pack a Television Set with the Lunch

In this hatbox-size set, tiny transistors eliminate all vacuum tubes except the picture tube itself. With "rabbit ears" antenna the 5-inch screen can capture a picture telecast 15 miles away. The experimental battery set, under test by RCA, weighs 27 pounds.

Corn-kernel-size Transistors Can Make Science Fiction Come True

Electronic brains using these devices can perform miracles. Yet construction is simple, as the giant model shows: a tiny germanium bar, three wires, and plastic case. With the twist of a button a transistor in this telephone increases volume for the hard of hearing.

National Geographic Photographer Willard R. Culver

From This Command Post a Television Director Fires Orders at Machine-gun Speed

A director of a television program commands an army of actors, musicians, and prop men. Here director Jim Silman (with headphones) rehearses the Allan Jeffreys show from above the stage at CBS's Broadcast House in Washington, D. C. When the clock ticks around to showtime, Silman swings into a frenzy of mental and vocal activity. To his cameramen, connected by telephone, he emits a steady stream of directions: "Swing around... sneak in... left... right... get on the piano... pan the keyboard." At his voice, prop men pour rain, make thunder; engineers adjust mike booms, rearrange spotlights; actors don hats, speed speeches, sit or stand.

This flood of commands is reflected on the three monitor screens immediately before Silman, one for each camera. The director selects the best picture and orders the switcher (left) to put it on the air; red screens reproduce this picture. Screens on the shelf above hold special picture effects and advertising. Technician (right) controls the sound. An announcer sits in the soundproof booth.

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Inside the television camera, however, the picture is focused not on a film but on a metal plate covered with thousands of tiny dots of a metallic element, cesium.

Each of these dots of cesium is photoelectric; that is, it has the ability to convert light into electricity. Each dot builds up an electric charge in proportion to the amount of light that strikes it. The lights and darks of the picture, therefore, are duplicated by several thousand proportionately strong and weak electrical impulses.

These impulses must now be moved, one at a time in perfect order, out of the plate. This is done by a process known as scanning. A needle-sharp stream of electrons, controlled by magnets, is sprayed across the plate like water from a hose, moving back and forth as your eye moves when you read a page in a book. As the electron stream hits each photoelectric dot in turn, its minute charge is knocked free and sent down a wire.

Scanner "Reads" at 3,600 Miles an Hour

To compare electronic scanning with reading a page is, admittedly, stretching a point. One page in an ordinary book has only 30 to 40 lines of type; the scanner divides the photosensitive plate into 525 lines. Also, a reader may be able to read one page of a book in two or three minutes. The scanner moves at 3,600 miles an hour and "reads" the entire plate—all 525 lines of it—30 times a second.

Altogether, it takes up to 8,000,000 separate electric impulses each second to represent the television picture from one camera.

In a glass-fronted soundproof booth the program director watches the output of all four cameras on monitors (television receivers connected to the cameras by wire) and, by simply pressing a button, chooses the picture he wants to send out on the air.

In New York, before I went to Mount Rose, I spent half a day in a director's booth watching this operation.

The television director in action is without a doubt one of the world's busiest men. He must watch each of the four monitors and the stage itself, behind the glass wall. He also keeps track of the cameras and talks constantly through a microphone to the cameramen, who wear earphones. He keeps up with the script, so he knows what's coming next and can prompt a forgetful actor. The orchestra leader may depend on him for cues.

From the studio the television picture, now dissolved into its electrical components, goes by wire to the network control room. Here connections have been set up and switches closed to forward the signals (1) to the network's own New York television broadcasting antenna, from which the picture is broadcast locally; and (2) to the A. T. & T.'s Long Lines building in downtown Manhattan.

The telephone company's job is to send

(Continued on page 101)

1. **Television Studio.** Camera and microphone turn living scene and sound into millions of electrical signals a second.

2. Network Control Center. Local and remote pictures converge for use in roundup programs covering several cities.

3. A. T. & T. Network Control Room. Telephone channels are set up here to carry TV signals across the country.

4. Home Receiver. Local station receives program signals from A. T. & T. relay tower or cable and broadcasts them. Your TV set turns signals into picture and sound.

Television Broadcasting Station

Telephone Office

Television Broadcasting Station

Telephone Office

Microwave radio relay towers stand about 30 miles apart, must be within sight of one another since signals fly only in a straight line.

Coaxial Repeater Station

Underground Coaxial Cable

How TV Pictures Flash Across the Country

To carry programs from network studio to home, millions of signals a second fly over wires and through the air. To transmit them, the American Telephone and Telegraph Company uses coaxial cable and, more recently, a chain of towers: the microwave relay system. Beamed from tower to tower, pictures reach your receiver in less than 1/50 of a second.

Coast-to-coast Relay of Television Pictures by Microwave

Mississippi River

Chicago

Alleghenies

New York


TELEVISION STUDIO

Fred Fehrenbacher

Fifth Avenue's Easter Parade Jams to a Halt Before TV Eyes

An Iowa farmer sees a World Series ball game; a Mississippi fisherman watches the Presidential Inauguration; an Oregon housewife glimpses the tragic aftermath of a Louisiana tornado. For such telecasts mobile TV cameras and transmitters speed to the scene, sometimes on an hour's notice. In large cities permanent coaxial cables, laid beneath the streets by the Bell System, stand ready for use at strategic spots. Otherwise, microwave sends the picture (pages 88, 96).

Here two NBC cameras focus on the scene between St. Patrick's Cathedral and Rockefeller Center (background). Inside the truck, a director and his staff work before monitor screens much as in the station studio (page 94). Cables looped over the tree lead to network facilities in a near-by building.

Inset: A radio reporter, wearing a shortwave receiver in his top hat and holding a portable transmitter, interviews an Easter parader.

Sharp-eyed Color Camera Demands Real-life Construction of Sets

Plaster, wood, and brick replace traditional painted flats in "To Live in Peace," Kraft Television Theatre's first color drama. A system of lenses, filters, and three tubes inside the camera breaks the scene's colors into separate sets of signals for red, blue, and green.

Television's Color Mixers Use a Panel of Dials for a Palette

Color TV receivers must blend the red, blue, and green signals sent over the air. Here research men at RCA Laboratories receive separate color components on test sets. Adjusting dials, they fade or brighten each shade to produce a balanced picture.

the millions of picture signals with a minimum of distortion to 63 broadcasting stations scattered from coast to coast.

The operating center in the Long Lines building is television transmission headquarters for the entire United States. At first impression it seems like a leisurely place. Facing TV screens along one wall sit four men who spend most of the day looking at television—and get paid for doing it.

Their job is not as relaxing as it looks, however. These transmission men are not watching programs. They are monitoring pictures, which is quite a different thing.

A Flicker Means Trouble

They pay no attention to the plot of the TV drama. But a flicker in the picture, a double image, or a momentary fading sends them into a flurry of activity. Beside each man's screen hangs a telephone. By calling the network control room and monitoring points along the relay system, they usually pinpoint a breakdown within seconds and alert the technicians to fix it. Meanwhile (if the difficulty is in the A. T. & T. facilities), the program is re-routed to another channel.

Other spurts of activity come on the hour, the half-hour, and the quarter-hour.

Our New York advertiser bought a coast-to-coast network for his program. The next sponsor, however, may want only stations along the east coast from Boston to Florida. This means that between the two programs the network must be rearranged.

It's done by pushing buttons on a big control board in the monitoring room. I watched a transmission man make the switch skillfully, pressing the knobs two at a time. He had just 20 seconds between programs to do it.

"Do you ever make a mistake and push the wrong button?" I asked Arthur Dittmeier, the transmission supervisor in charge.

"It has happened," he admitted, "but very rarely. When we do make a mistake, it doesn't stay made very long. Usually we catch it here. But if we don't—the station owners monitor their own shows, you know, and when they suddenly find they're getting wrestling matches instead of Marilyn Monroe, they let us know promptly. And I mean promptly!"

The program signals move from the monitoring room to the roof of the Long Lines building. Here they are mounted on super-high-frequency radio waves and amplified so that they can make the jump to the next relay tower in Martinsville, New Jersey, 25 miles away.

The superhigh-frequency (SHF) waves used in microwave relays are a little longer than a man's finger. About four billion of them fly past a given point in a second. They can be focused, like rays from a spotlight, into a sharp, one-directional beam. This is done through a lens in the antenna, developed by Bell Laboratories. The beam can be sent from relay to relay with less than one watt of power.

Amplified and modulated, the television picture is ready to begin its transcontinental trip. It will leap from tower to tower 106 times on the way. And it will reach San Francisco in about 1/50 of a second after it leaves New York (color diagram, page 96).

At each tower the signal is reamplified and its frequency changed again—raised or dropped by 40 million cycles a second. This is to avoid the double images, or "ghosts," that might result if part of the signal beamed at one antenna overshot its mark and reached the next antenna down the line. For the same reason, the relay towers are placed in a slightly zigzagged position.

Telephone engineers have taken elaborate precautions to prevent breakdowns in the unattended relay stations. At Mount Rose, for example, Jerry Miller showed me a Diesel-powered 40,000-watt generator that turns itself on if power fails. An 8-month supply of Diesel oil is kept on hand.

He also showed me a miniature air-cooling system which keeps the station's vacuum tubes from overheating by blowing a jet of air on each individual tube.

Alarm System Guards Station

Standing guard over all the Mount Rose equipment is an intricate alarm system. If anything goes wrong, it flashes a warning to a telephone exchange in Reno, where a repair crew is always available. The alarm not only reports trouble, but blinks a light in a chart showing specifically what the trouble is—whether it is a burnt-out tube, a shortage of Diesel oil, or even if the front door is open!

If a microwave channel does fail, the audience watching the television program at home usually does not know the difference. In most cases, before the failure becomes noticeable to the human eye a much keener electronic eye has detected it and switched the program to a reserve channel.

Sno-Cats Climb to America's Tallest Telephone "Pole," a Relay Station on Mount Rose

Near the top of this 10,778-foot Nevada mountain, Bell System maintains the highest link in a chain of 107 radio relay stations stretching between New York and San Francisco. This unattended station (on horizon) uses microwave radio instead of wires or cables. It transmits television programs and hundreds of telephone calls simultaneously. Megaphonelike antennas (inset), which dwarf human visitors, catch east- and west-bound signals, send them through amplifiers to boost their power, and speed them on. If equipment in the Mount Rose tower breaks down, alarms flash in Reno and repairmen rush to the mountain. In winter they use Sno-Cats, skis, snowshoes, and a quarter-mile-long aerial tramway (opposite).

♣ **Leaving Sno-Cats Below, Linemen Jump the Last Lap in a Ski Lift**

♣ Inside the relay tower telephone repairmen enjoy all the comforts of home: an easy-chair living room, bunks for 10 men, showers, and this all-electric kitchen. Should blizzards trap the men, freezer holds a month's food supply.

At the end of the line—that is, at each of the network broadcasting stations along the relay route—the television signal gets the same treatment it got in New York, only in reverse.

It goes through a telephone office to the local broadcasting outlet. Its frequency is stepped down several billion cycles, its power raised again, and it goes out on the air.

Your television antenna picks up the broadcast waves and shoots the electrical impulses down into your receiver, where an electronic scanner like the one in the TV camera turns them back into a picture.

We have seen how a television show is carried across the country from a studio. Many programs, of course, do not originate in studios at all, but on football fields, in zoos, or on street corners. This calls for more facilities: mobile relay stations mounted on trucks, and sometimes miles of temporary wiring. When President Eisenhower made his opening campaign speech at Abilene, Kansas, June 4, 1952, telephone engineers had to set up 300 miles of relay channel almost overnight.

Color TV Brings New Problems

In December, 1953, the Federal Communications Commission stamped its official approval on an all-electronic system for TV broadcasting in color, and the television industry prepared to blossom out in red, green, and blue.

Color television assembly lines began rolling in March, 1954. The first sets, the industry warned, would be expensive: $700 to $1,000 or more. But for viewers who do not want to buy a new color set, black and white receivers will still serve. The new all-electronic color system is "compatible," which means the signals can be picked up either in color or in black and white.

In New York I watched a demonstration of color television. To show what the new cameras would do, the program displayed a luncheon scene: a table laden with yellow bananas, bright-red apples and tomatoes, green lettuce, rare beef, and glistening silverware. Pictures on the screen were clear and sharp, colors vivid and lifelike.

To A. T. & T. engineers, network color television presents new problems. The signals required to transmit a color picture are far more complex than for black and white.

A color camera, using mirrors and color filters, breaks the picture up into three separate sets of signals—one for red, one for blue, one for green. All three must be sent through the air at the same time (page 100).

It's a delicate operation, and even a minor distortion can be disastrous. As one Bell System official put it, "If the color signals get even a little way out of phase, we have green-faced actors—and red-faced engineers." Despite the difficulties, the first tests of coast-to-coast color transmission, held late in 1953, were eminently successful.

Today the Bell System has $100,000,000 invested in television transmission, substantially more than any of the four television broadcasting networks. Yet the telephone company, its engineers assured me, is not really "in television" at all.

For a fuller explanation of this paradox, I called on Cleo F. Craig, a telephone employee for 40 years and since 1951 president of the American Telephone and Telegraph Company.

I met Mr. Craig in his comfortable office on the top floor of the A. T. & T. Building, 195 Broadway, New York.

"Our business," he explained, "is not television, or radio, or any other specific medium. We're in the business of transmitting information from one place to another. Our job is to serve the community, and our particular branch of service is communication.

"A television picture, to us, is another form of communication, another piece of information to be sent from here to there. If we have the facilities, we'll send it.

Into the Movies—and Out

"It hasn't always been easy for us to see just where our job ends. In the late 1920's, for instance, we got interested in the movies. Working with telephones, our men knew a lot about sound equipment and acoustics; so we began designing and installing sound systems for talking pictures. We got out of that.

"The same thing happened in radio. We built and operated a pioneer radio station, WEAF, here in New York, and there we were, in the entertainment business. We got out of that, too.

"Today our policy is this: We follow a line of research in our laboratories long enough to see if it has some application to communications. If it doesn't, we drop it. Sometimes we come up with something that is useful to us, but also has other uses outside our field. In that case we make what we need and license other manufacturers to make their own."

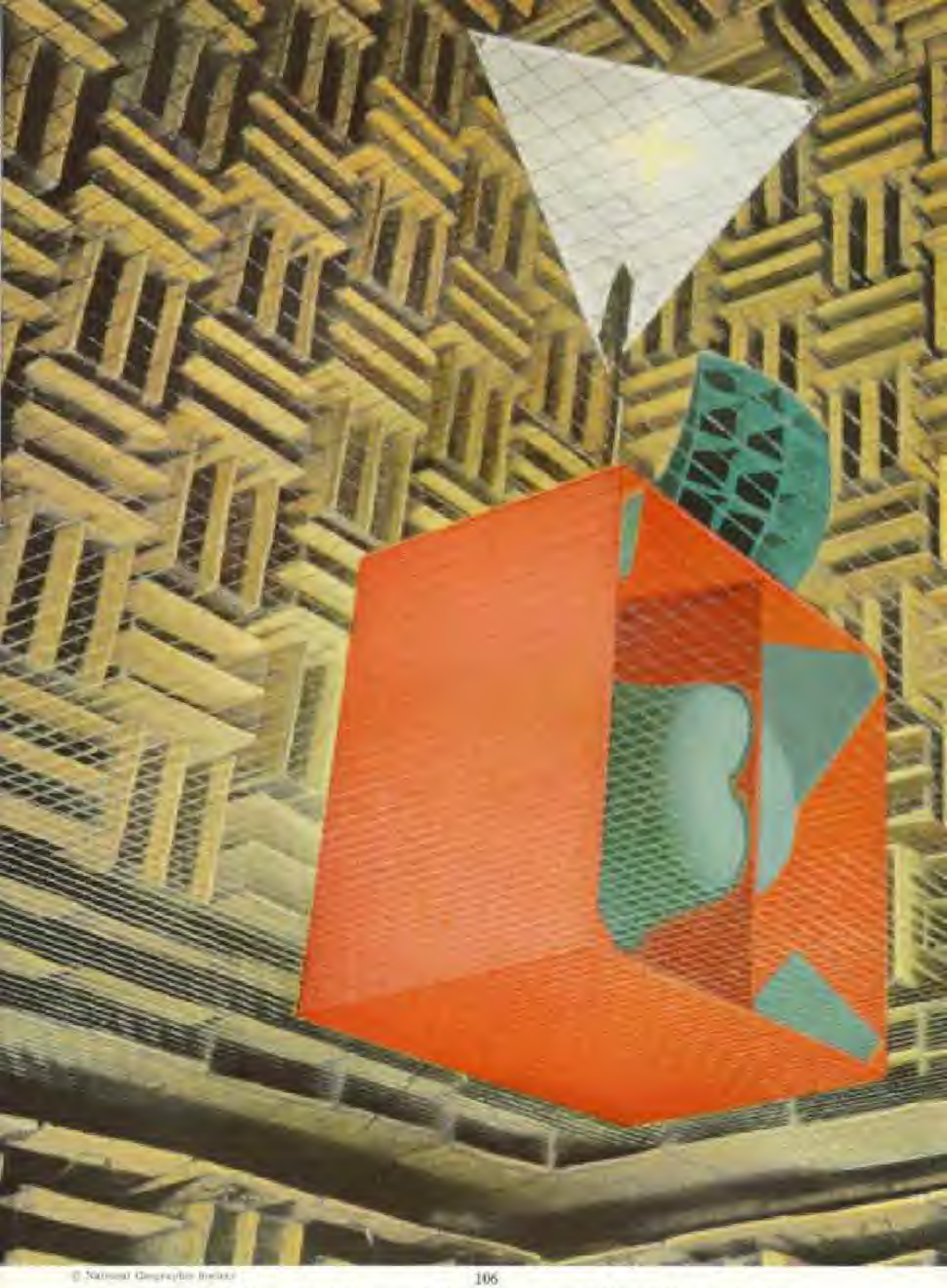
(Continued on page 113)

Electronics by National Geographic Photographer Willard R. Culver

Solid Sounds: Bell Scientists Build Three-dimensional Models of Words

To study ways different people say the same words, Bell Laboratories rebuild sounds in plastic. These ranges of peaks and valleys represent spoken numbers: (left to right) 7, 6, 1, 8, 9. Green spectrograms below are graphs of the same words in two dimensions. In the plastic "seven," for example, high frequencies—like the hissing sound of "s"—are shown by peaks on extreme left. Peaks farther right represent lower frequencies of vowels. The time it took to say "seven" can be measured by the model's thickness from front to back.

Through such studies, Bell engineers may someday build long-distance telephone exchanges which will analyze your voice. Instead of sending words, machines will transmit much simpler code symbols describing what you said and how you said it. At the other end, other machines will translate the symbols into a reasonable facsimile of your voice. Equipment like this would permit many more conversations to go over expensive long-distance circuits.



Walls 8 Feet Thick Surround Bell Laboratories' Weird Room of Silence

Here scientists can study pure sound. Deep fiberglas wedges in the walls of this free space room, or anechoic chamber, stifle every echo and eliminate all outside noises. The utter silence is oppressive to some, frightening to others. Visitors are often startled to hear their hearts beating and clothes stretching as they breathe.

Suspended in Mid-air, a Girl Strains to Hear Dead Sounds

In a hearing test, two loudspeakers, the blue honeycomb "tweeter" (top) for high sounds and the "woofer" for bass, pour out notes of varying pitch and intensity. With a push-button box in her lap the subject signals when once she can hear; a microphone measures intensity of sounds inside the girl's ear. White triangle shields light

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A Steel Rolling Mill Produces . . .

The United States Steel Corporation uses television to increase efficiency and improve quality in its Gary, Indiana, rolling mill. Here finishing mills squeeze a white-hot slab under 4,000 tons' pressure, flattening it like dough under a rolling pin to a quarter-inch thickness. The thin strip shoots from the mills (above and left) at 2,000 feet a minute, hisses through cold-water sprays, and roars down a 395-foot table of rollers. Occasionally a "cobble" develops: the ribbon piles up in glowing loops, as in the example shown at left. The mill operator, watching his TV screen, can quickly catch trouble otherwise hidden by sprays and guard rails. Red lights warn workers away.

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. . . Television's Hottest Program

Before TV was installed, a cobble might mean a 15-minute delay, a loss of 120 tons of steel. Watching the screen, the operator can take swift preventive action—speed up the table rollers, slow down furnace output—without stopping production.

Right: A serviceman from the Illinois Bell Telephone Company, which installed the television circuit, gives the receiver a routine checkup.

Nike, Slim and Lethal, Has a Brain in Its Head and a Rocket in Its Tail

Designed by Bell Laboratories, Nike's electronic brain guides it to an enemy plane no matter how the pilot may dodge. When plane and missile come together, Nike's warhead explodes. Above: The missiles on launching platforms are hauled to firing site at White Sands Proving Grounds, New Mexico. Opposite, above: A bonded workman injects liquid propellant into Nike's tail. Fueling crewmen must wear rubberized suits, and a fireman stands by with ready hose. Below, left: Battery-control crew in mobile van watch Nike on radar screen as it guides itself to the target. Below and right: Photographs snapped ½ second apart show Nike's take-off. The black tail, a booster rocket, drops off when fuel is used up. At top speed Nike goes faster than a rifle bullet (page 120).

✦ Robot Brain Remembers the Route for Each Long-distance Call

Someday American telephone users will be able to dial friends in distant cities, as residents of Englewood, New Jersey, can already do (page 1141). To make this possible, telephone engineers are building new, complicated electromechanical brains into telephone exchanges. This machine, called a card translator, is the brain's memory. Information is stored in 1,020 metal cards; within seconds the brain can find seven possible telephone routes to any city.

✦ Punched Tape Keeps a Record of All Your Phone Calls

When you place a call through one of the new robot telephone exchanges, a tape-punching machine instantly goes into action. It takes down your number, the number you're calling, and how long you talk. If you get a busy signal or if your friend doesn't answer, it records that fact. Later the tape feeds through other machines which figure your monthly bill.

Kodachromes by National Geographic Photographer Willard R. Culver

One example of such a device is the miraculous transistor. Another, announced in April, 1954, is a silicon battery which turns sunlight into electricity (page 117). Both were products of the same broad research program.

After World War II a group of Bell Laboratories scientists under William Shockley, a physicist from Massachusetts Institute of Technology, was studying a class of elements known as semiconductors. Germanium, found in zinc ore and in some coal ash, is a semiconductor; so is silicon, found in sand.

Electronically speaking, a semiconductor is in between copper, which is a conductor, and glass, which is an insulator.

How the Transistor Was Born

"Semiconductors had been in use since the days of the old crystal radios," Ralph Bown, a vice president of Bell Laboratories, told me. "One common use was as lightning arresters. But we didn't understand how they worked."

In the process of finding out, two of Shockley's colleagues, John Bardeen and Walter H. Brattain, invented the transistor publicly demonstrated on June 30, 1948. "It was one of those fabulous cases," said Bown, "where research paid off in a hurry."

A transistor is a pinhead-sized crystal of extremely pure germanium or silicon to which a carefully controlled impurity, such as gallium or arsenic, has been added in a ratio of one part per 100,000,000. The effect of adding this trace of impurity is to upset slightly the balance of electrons in the germanium.

After the impurity is added, fine wires are attached to the transistor so that an electric current may be passed through it. It is then usually encased in plastic to secure the connections and protect the germanium.

What does a transistor do? The simplest answer is: most jobs that a vacuum tube does, but far more efficiently—plus a good many that a vacuum tube can't do (pages 89, 93).

What a vacuum tube (or a transistor) does is to control the flow of a stream of electrons. Using vacuum tubes, scientists can make an electric current oscillate thousands or billions of times a second. Or they can take a current which is already oscillating and rectify it, so that it flows in one direction. They can take an extremely weak current, like the one that moves up and down your television antenna, and boost its power a million times without changing its characteristics.

A vacuum tube "boils off" its electrons from a heated filament suspended in a vacuum, much like an electric light bulb. And like a light bulb it is fragile and easily damaged by shock and vibration. Because of its fairly complex structure, there is a practical limit to how small it can be made.

A transistor rectifies, amplifies, and oscillates a current just as a vacuum tube does, but all inside a solid piece of metal—no vacuum to be maintained, no glass to break, no delicate suspended parts. And the whole thing can be smaller than a kernel of corn.

The most important advantage of a transistor, however, is the power it saves. In a vacuum tube, most of the electric power goes to heating the filament; this heat is quickly dissipated and the power lost. A watt or more of electricity may be used to produce an output of only a few thousandths of a watt.

In some cases (as we saw at Mount Rose), so much heat is given off that air cooling is necessary. In building complex electronic computers, heat from the vacuum tubes is often the chief limiting factor.

A transistor requires no heat at all. As a result, it usually will operate with as little as 1/1,000,000 the power of a vacuum tube doing the same job.

Today some 40 American electronic manufacturers, including General Electric, Sylvania, Raytheon, Radio Corporation of America, and the Bell System's Western Electric, are making, or preparing to make, transistors under Bell patents.

Recently RCA opened a display to show consumers what to expect in a transistorized future. They showed a variety of experimental gadgets, none in actual production, stressing smallness and operating economy.

Portable TV Runs on Batteries

One was the world's first portable television receiver, enclosed in a case the size of a hatbox. Battery-run, it needs only 13 watts of power, as contrasted with about 300 watts for conventional TV sets (page 93).

Another was a microphone-transmitter built entirely inside a toothbrush box and run by a finger-sized (pen-light) battery. It can broadcast to any near-by radio.

An instrument resembling a child's toy piano, equipped with a battery-run transistor transmitter, could play music with deafening volume through a radio loudspeaker.

Transistorized hearing aids have now been made as small as a cigarette lighter, weighing

only about two ounces. Some run on a single battery little bigger than an aspirin tablet.

The U. S. Army Signal Corps has estimated that, by substituting transistors for vacuum tubes in radar spotting and artillery fire-control equipment, power requirements could be cut 90 percent, weight 80 percent. Batteries could be carried in cartons instead of carloads.

The Army is also testing a transistorized radio receiver so small it was instantly named the "Dick Tracy," after the comic-strip detective's wrist radio.

The Future: Who Knows?

But transistor experts, at both RCA and Bell Laboratories, stress that ingenious gadgets like these scarcely hint at things to come.

"Asking us to predict what transistors will do," one of them told me, "is like asking the man who first put wheels on an oxcart to foresee the automobile, the wrist watch, or the high-speed generator. All we've done so far is to substitute transistors for vacuum tubes in a few existing devices."

To telephone engineers, however, the transistor offers more than futuristic fantasies. It is already doing a vital job in the Bell System's new robot telephone exchanges. It helps to run an electromechanical brain that not only handles long-distance calls automatically but keeps track of how long you talk, and then figures out your bill (page 112).

Since November, 1951, citizens of Englewood, New Jersey, have been able to pick up their telephones and dial numbers in cities such as San Francisco, Sacramento, Philadelphia, Detroit, Chicago, or Boston as easily as you can dial your neighbor down the street. They do it without talking to any operator.

The "operator," in fact, could not talk to them if it wanted to. It is a maze of wires, switches, magnets, resistors, capacitors, tubes, and, of course, transistors.

I went to Englewood to try long-distance dialing for myself. I was met at the exchange by William A. Frylinck, the plant service supervisor who has been with the experiment since it began.

With Deadly Accuracy, Nike Hunts Down a Pilotless Plane

Nike, named for the "Winged Victory" of Greek mythology, will serve as a key weapon in America's defense against enemy bombers. The rocket can knock down planes flying at 30,000 feet. Here at White Sands Proving Ground, New Mexico, Nike cuts under the wing of a B-17. A split second later its warhead explodes, tearing off a wing. As the plane plummets to earth, a motor zooms off at an angle

Department of Defense

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National Geographic Photographer Allen E. Fletcher

Television Helps a Bank Depositor Balance Her Checking Account

This customer went to the Riggs National Bank in Washington, D. C., with a question about her bank statement. An officer seated her in front of a television screen and phoned the bookkeeping department, in another building a block away. A private television system connects the two buildings. Within minutes the client's deposit slip, in her own handwriting, flashed on the screen and her question was answered.

"Here," he said, handing me a telephone. "Try it out. Call San Francisco."

"I don't know anybody in San Francisco," I said.

"Call the time signal," he said. "Check your wrist watch. First dial 318; that's the San Francisco area code. Then dial the local number. For time, that's RO 7-8900."

I dialed 318, RO 7-8900 while Mr. Frylinck took out a stop watch. He pressed it as I dialed the final "0."

It had ticked off 12 seconds when I heard the ring in San Francisco; in 14 seconds I heard a voice saying, "The time is 3:12 . . ." My watch, I noticed, was exactly three hours and two minutes fast. I made a swift mental calculation and set it back two minutes.

"A little quicker than average," said Mr. Frylinck, putting the stop watch away. "It sometimes takes as long as 16 seconds from dial to ring."

"Suppose I wanted Chicago instead of San Francisco?" I asked.

"You dial exactly the same way, except for Chicago the area code is 312. For Detroit it's 313, for Boston 617. Our green book now lists 14 different area codes. Eventually it will have about 100, covering every part of the United States and Canada."

Transcontinental Busy Signal

"What happens if a customer dials San Francisco and the line is busy?" I asked.

"He gets a busy signal, just as he would on a local call. There's no charge for that, of course, though we hope he'll try again and complete the call."

"And if he dials a wrong number?"

"The subscriber calls an operator—a human one, this time—and lets her know immediately. Then he won't be billed for the call.

"With customer long-distance dialing we have to be especially careful about wrong numbers, because each mistake ties up a long-distance toll circuit. So we urge people not to trust their memories but to write down every out-of-town number.

"Now that you've tried it," Mr. Frylinck added, "let's go and see it."

He led the way into a vast room filled with flat, gray steel cases, some closed, some open and revealing panels of dimly glowing tubes and banks of relays and switches. Off to one side a man on a ladder spliced wire; another man wrote at a desk. Overhead cables looped and twisted in intricate complexity.

How the "Brain" Handles Your Call

There were no switchboards, no flashing lights, no human voices. Yet even while I watched, calls were coming in to the "brain" bound for points thousands of miles away. Unerringly it selected the right telephone from among millions of possible telephones, made the proper connections over distant trunk lines, rang the bell, and waited for an answer.

Actually, the brain is made up of four separate sub-brains, working together with split-second coordination.

To understand how it works, suppose Ed Smith of Englewood calls up Pete Jones of San Francisco, Jones's number being MArket 4-9970. The instant Smith picks up his phone, the brain goes into action.

As he dials the 10 digits, 318, MA 4-9970, one unit of the brain memorizes them. As soon as he finishes, a second unit reads them and instantly recognizes the "318" as San Francisco. In a flash it finds a trunk line, closes switches, and the connection is made with the San Francisco exchange.

Then a third unit takes over and electronically pulses the *last seven* digits of the number across the country. It drops the 318, since the Englewood brain is now, in effect, operating the dial equipment *inside* the San Francisco exchange.

All this in 10 seconds or less!

When the brain first picked up Smith's call, one of seven busily clicking machines in an adjoining room was called into action. These are the automatic message accounting machines (AMA), another product of the fertile Bell Laboratories.

When Smith first dialed, an AMA machine automatically recorded on tape his number, the San Francisco number, and the date, hour, minute, and second. When Jones answered, AMA wrote down the time again; it also recorded exactly when they hung up.

Later the tape will be fed to other machines which will separate all Smith's calls and add up his telephone bill for the month. So far, none of Englewood's mechanized accountants has ever been caught in a mistake.

Long-distance dialing went into Englewood as an experiment. Bell System engineers wanted to find out (1) whether the equipment was foolproof, and (2) whether customers would like it. The answer to both questions is yes.

Englewood's telephone subscribers from the start were offered a choice: They could dial their own toll calls, or they could call an operator and let her do it. A recent survey shows 90 percent of the dialable toll calls are now being dialed. This excludes person-to-person calls, which automatic equipment won't handle without human assistance.

Nationwide Dialing Is Coming

The Bell System is now going ahead with plans to put customer long-distance dialing on a nationwide basis. To find out how long it will take, I talked to Bill Nunn, of A. T. & T.'s long-range planning department.

"It's a complicated job," he said. "Too complicated to set an exact target date.

"Before we can have national long-distance dialing, you see, we must first have nationwide *local* dialing. That alone may take 10 to 15 years to complete. About 20 percent of the telephones in the United States are still 'manual'—that is, an operator handles local calls.

"The change-over to long-distance dialing will come gradually. A good part of it has already taken place. Almost half of our long-distance calls are already dialed directly by an operator in one city to the subscriber in another city, using equipment like Englewood's.

"In Washington, D. C., we recently installed what we call 'wider range dialing,' another preliminary step. Washington subscribers can now dial as far as Baltimore, Annapolis, and Frederick, Maryland—a range of 40 miles."

You can now make calls through the Bell System to 102 foreign countries and territories. Of these, only Canada is included in plans for customer long-distance dialing.

Even for overseas calls, however, Bell en-

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Bell Solar Battery Uses Silicon to Turn Sunlight into Electricity

Scientists have long dreamed of harnessing the sun's energy, which daily offers to the earth power comparable to all its coal, oil, and gas combined. This year Bell Laboratories came up with one answer: a battery that directly converts light into electric current. Its working parts, which never wear out, are thin strips of specially coated silicon, a common element found in sand. A square yard of silicon surface can power a desk lamp; a factory would require acres of silicon. Here three co-inventors, D. M. Chapin, G. L. Pearson, and C. S. Fuller, use a book-sized solar battery to run a transmitter whose signal is picked up by the radio at left.

gineers are planning a major improvement. Starting in 1955, A. T. & T., working with Great Britain and Canada, will lay the first transatlantic telephone cable. It will stretch more than 2,360 miles along the sea bottom, three miles deep in places, from Nova Scotia to Newfoundland to Scotland. It will cost $35,000,000.

Built-in vacuum-tube amplifiers, housed in the cable sheathing, will boost the telephone signals every 40 miles along the way. When it is finished, probably in 1956, the cable will be able to carry 36 conversations at once.

At present overseas phone calls go by radio, easily disrupted by weather and even by sunspots. Over the cable, calls to Great Britain will be clear as domestic calls.

Twenty-five years of research went into the cable. The hardest problem was to make tiny amplifiers rugged enough to withstand pressures up to five tons to the square inch.

Each amplifier contains three vacuum tubes. When a tube wears out, replacement will be costly. First, a ship equipped with electrical detecting devices will locate the trouble spot. Then the cable will be hauled up with grappling hooks, and a new section spliced in. Scientists estimate the tubes are good for at least 20 years—they hope much longer.

"The way to understand the telephone company," one A. T. & T. public relations expert told me, "is to think of it as a nerve system. Think of the country as a big, scattered organism; the telephone wires link it together

just as your own nerves coordinate your body.

"At first, the telephone wires carried only sounds and corresponded to the nerves that carry sound from your ear to your brain. Now, with television, they're carrying sight—there's the optic nerve.

"But your body also has *motor* nerves. Your brain sends a message along these nerves telling your finger to move, and it moves. Well, telephone wires do that, too."

"Remote control" by telephone is one of the newest and least known of Bell System services. One of the big oil companies, for instance, controls valves on its pipelines in Illinois by pressing buttons in its New York office 960 miles away.

Commercial firms are big users of a different kind of remote-control device, the teletype. Clerks in a New York brokerage office, by punching a keyboard, can quote the latest stock prices instantaneously in branch offices across the United States.

The teletypewriters they use, actually long-distance electric printing machines, are made by the Teletype Corporation, an A. T. & T. subsidiary. Their messages are carried over telephone company lines. In 1953 the Bell System served 71,000 teletypewriters in the United States.

One of the biggest mechanical changes in the history of the newspaper business began in 1951, when the Associated Press, the United Press, and the International News Service, using Bell System facilities, opened a new kind of teletype circuit.

The teletypesetter, popularly known as "TTS," not only carries news stories to member or subscribing papers but even runs the linotype machine and sets type for the presses by remote control.

Printing News by Long Distance

Before TTS, wire stories went to newspapers over ordinary Bell System teletype machines. After editing, they were taken to the newspaper's composing room, where linotype operators set them in type.

With TTS the story is punched in code on a tape about an inch wide. The tape is carried to the linotype machine and fitted into a boxlike device which operates the linotype keyboard automatically.

By the end of 1953 more than half the daily papers in the country were getting TTS service from the AP, UP, or INS, and more were subscribing every month.

During World War II the Bell Laboratories went to war, along with the rest of American

← 1888 Telephone Office Used Gas Lights if Newfangled Electric Lamps Failed

When this picture was taken, the telephone was only 12 years old, the incandescent light bulb even younger. The switchboard, on Manhattan's Cortlandt Street, formed part of the Bell System's first big central telephone exchange. New York City then boasted about 10,000 phones; today it has 5,695,500.

Harris & Ewing photo

↓ 1954 Telephone Office Uses Radio Equipment to Reach Ships at Sea

A. T. & T. started its ship-to-shore telephone service in 1929 with the S. S. *Leviathan*. Today, through this high-seas control room in New York and others like it in San Francisco and Miami, an average of 60 telephone calls a day goes out to the 50 passenger ships equipped to receive them. Technicians plot the ship's position, then establish contact through powerful shortwave transmitters.

To call a friend on shipboard, a United States telephone subscriber simply dials any long-distance operator, who has a directory of ships served and their approximate positions. She connects him with the proper high-seas office. A 3-minute call costs $4.50 for a ship close in, $12 for a vessel in the Indian Ocean.

These technical operators are contacting the S. S. *Independence*, near Aden.

National Geographic Photographer B. Anthony Stewart

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Wide World

This Telephone Pole Is 30 Feet High!

The 1952 record-breaking blizzard near Donner Summit in the High Sierra buried telephone lines—and almost everything else. These linemen on snowshoes scrape away snow to inspect crossarms for damage.

industry. Bell scientists had special knowledge of ultrahigh-frequency radio waves, the type used in radar. Many radar devices, including radars for directing antiaircraft guns, and electronic computers to aim them, were developed in the Laboratories.

Nearly a third of the 6,000 scientists and technicians at Bell Laboratories have stayed in military research. Among other things, they have developed a new and spectacular electronic device: the Nike guided missile.

Nike, named after the Greek "Winged Victory" goddess, is an antiaircraft weapon with which the Army hopes to protect American cities and atomic plants from enemy aircraft attack. It is a slim torpedo-shaped rocket which can fly faster than sound.

Launched from a platform on the ground, Nike can race to meet an enemy bomber thousands of feet in the air and overtake and destroy it no matter how the pilot may twist and turn (pages 110, 114). Installation of the first Nike base is under way at Fort Meade, 24 miles northeast of Washington, D. C.

The all-important electronic brain that controls Nike's flight is made by Western Electric Company, A. T. & T.'s manufacturing subsidiary. Other parts of the rocket are made by Douglas Aircraft.

Thus the telephone's "nervous system" not only brings America together by sight and sound and touch, but also controls a powerful muscle and a hard clenched fist to defend the country if it becomes necessary.

Everyone's Servant, the Post Office

Deluged by Record Mail Volume, the Postal Service Streamlines Its Operations and Speeds Delivery with New Techniques

By Allan C. Fisher, Jr.

National Geographic Magazine Staff

With Illustrations by National Geographic Photographer Volkmar Wentzel

RECENTLY Postmaster General Arthur E. Summerfield, who left a highly successful business career in Michigan to join President Eisenhower's Cabinet, was discussing the size of the United States Post Office Department. With a rueful smile he recalled his reaction to the Department's sprawling dimensions on the day he assumed the job of No. 1 postman.

"I walked into my office alone," he told me, "and received my first surprise. That office was overwhelming—almost as big as a basketball court! After a hike around the room I sat at my desk and picked up an organizational chart.

"The chart gave me another surprise, for not until then did I realize the full magnitude of the Post Office. I thought, 'Five hundred thousand employees! Why, this organization must be as large as General Motors!' "

It is just as large, in fact, and in some respects far larger. Including all divisions, the automotive giant employs more people (517,000), but no company on earth can match the extent of the Post Office's far-flung operations or approach the number of transactions it conducts with the public.

Mail Volume Grows Rapidly

Few comparisons could have been more meaningful to the new Postmaster General, in private life a General Motors (Chevrolet) automobile distributor. And today no one knows the significance of that comparison better than the Department's hard-working executive, called "the General" by his associates.

During 1954 Americans will deluge General Summerfield's army of postmen with a record *54 billion* items, more mail than is sent by the rest of the world combined.

Since 1940 United States mail volume has nearly doubled, for an average growth of about seven percent each year. And still the upward spiral continues.

Obviously, the size of the Postmaster General's private basketball court is entirely consistent with the size of his Department and his job.

Rarely, indeed, does the Post Office undertake anything on a small scale. Just consider a few of its rotund, jumbo-size operational figures.

The Department maintains more than 40,000 post offices. Its current income exceeds $2,300,000,000 a year. Its mail routes total approximately 2,250,000 miles. They reach every hamlet in the Nation, no matter how remote, and link the United States with countries around the globe.

Postmen on their appointed rounds use 27,000 Government-owned or rented vehicles. Their office-tied colleagues sell 23 billion stamps each year and handle more than 900 million "special service" transactions, such as issuing money orders and registering letters.

Postal Savings Exceed Two Billion

The Postal Savings System, with deposits of $2,341,000,000, is one of the world's largest savings banks, and the Department's rental program—22,800 leased buildings—makes our Post Office the Nation's largest real-estate operator and tenant.

Somehow amid these varied pursuits the Department finds time for a number of odd jobs. It sells internal revenue stamps for Federal tax payments on property transfers and migratory bird stamps that are attached to hunting licenses. It manufactures and repairs locks and mailbags—and even distributes flags for the coffins of deceased veterans.

Postmaster General Summerfield describes his charge in this fashion:

"Actually, the Post Office is a combination of a delivery service, a bank, an insurance and collecting agency, a license bureau, a printing office, and an information center.

"It is also the greatest as well as the most economical of all the social services in our modern society. No other agency of government is so close to the daily life of each


N·S
RACK 3
K·M
RACK 2
A·1
RACK 1

community or so personal in its relations with our people."

Yet most of us are inclined to take the postal service pretty much for granted. We mail our letters of love, sympathy, friendship, or business and seldom give their safe delivery a second thought.

How, then, does the omnipresent but little-known Post Office operate? How does it move the paper blizzard that engulfs it daily?

Seeking the answers, I visited post offices large and small, talked to scores of officials, and traveled with the mail afoot, on horseback, in rail and highway post offices, and by helicopter.

I found the service astir with change. The Postmaster General and his key aides are pressing a vigorous modernization program to cope with the increasing work load.

Seven Bureaus Operate Postal System

The Department keeps abreast of its job through the well-integrated work of seven large Bureaus: Operations, which supervises post offices and carriers; Transportation; Finance; Facilities, responsible for real estate, purchases, and vehicles; Personnel; the Comptroller; and the Chief Postal Inspector's Office. Except for the last two, both specialized branches, all the Bureaus are headed by former executives of large business firms.

For a firsthand view of the flood tide of mail, officials conducted me on attic-to-basement tours of the Nation's two largest post offices, New York and Chicago. Together they handle more than 7.5 billion pieces of mail a year and yield 15 percent of the Department's total revenue.

New York, ranking No. 1, boasts perhaps the most famous post office building in the world, thanks to this inscription across its broad Eighth Avenue façade:

> NEITHER SNOW NOR RAIN NOR HEAT NOR GLOOM OF NIGHT STAYS THESE COURIERS FROM THE SWIFT COMPLETION OF THEIR APPOINTED ROUNDS

Thus wrote the Greek historian, Herodotus, about 430 B.C., in praise of mounted couriers employed by King Xerxes of Persia. The translation is by architect William Mitchell Kendall, who designed the building more than 40 years ago.

Since then the quotation has become world-famous. Many persons, both here and abroad, believe that it is the Department's official motto. Actually, the Department does not have an official slogan.

'Twas the week before Christmas when I visited the Big City, and its citizens were posting mail at the rate of 25 million pieces every 24 hours. Postal employment, normally 36,000, had jumped to 52,000. Experienced employees were working overtime.

Peter J. McEnter, an assistant general superintendent, acted as my host. First, for an over-all general impression, we trudged around and then through the huge General Post Office.

Let's assume you are walking with us.

Post Office Resembles a Factory

It's late afternoon; the day's mail volume is nearing a peak. Outside the building big olive-drab trucks push their tail gates up to the high unloading platform. Workmen swarm aboard and toss out scores of sacks crammed with letters.

Foremen shout commands, and quick hands pile mounds of mail on big wagons. Then off go the wagons, some pushed by workmen, others pulled by tractors insistently beeping with their horns for right of way.

Retreating inside, you find yourself in a world of mechanical gadgetry. Now you are walking beneath a maze of conveyor belts bearing streams of letters. A moment later you are watching hundreds of envelopes whiz through canceling machines. On another floor you see parcels cascading in a brown flood down a huge metal chute—"Niagara Falls," workmen call it (opposite page).

Your impression? A strange kind of factory, for that's essentially what a large post office is. And possibly you conclude that the postage stamp, most prosaic of purchases, may well be the world's best bargain.

← **A "Niagara Falls" of Parcels Seems Ready To Swamp These New York City Clerks**

The Nation's largest post office serves only two of New York's five boroughs—Manhattan and the Bronx. Yet it earns a tenth of United States postal revenue, and every day it dispatches an average 17 million pieces of mail, including 192,000 parcels.

A kind of ordered chaos prevails inside the cavernous halls where this avalanche is handled. Here a pre-Christmas flood, swept in by conveyor belt, pours down a metal slide which employees dub "Niagara Falls." Parcels fly in many directions as clerks separate them by regions and States; elsewhere they are sorted by cities and distribution centers.

Photographs by National Geographic Photographer Volkmar Wentzel and Dean Conger


HARDWARE
GROCERIES
DRY GOODS
ANDERSONS

← South Dakota's First Highway Post Office Gets a Warm Welcome in 8° Cold

Highway post offices, introduced in 1941, are replacing mail trains in many areas (page 134). As in railway post offices, clerks separate mail in transit, thus reducing handling time and speeding delivery. The roomy, specially built buses stop only at post offices and operate on tight schedules. They do not sell stamps or accept wayside letters. Most "hypos" are Government-owned; contractors and railroads operate others.

On January 11, 1954, a contractor inaugurated the Nation's 123d highway post office route, 316 miles between Philip and Sioux Falls, South Dakota (page 136). Here, bundled against biting cold, citizens of rural Marlo listen to a speech by Mayor A. J. Geisler as the traveling post office arrives. Antique car and stagecoach (left) led a welcoming parade.

← Sioux Chief Sends Greetings: President and Postmaster General Receive Them at the White House →

When the highway post office reached Chamberlain, South Dakota, on its first run, Sioux chieftains clad in buckskin, feathers, and paint met the bus. Their purpose, anything but hostile, was to mail letters of greeting for two bigger chieftains in Washington—President Eisenhower and Postmaster General Arthur E. Summerfield.

At left, Chief Dan Grass Rope, 92 and a recent bridegroom, hands one message to the postal clerk, while Chief Swift Horse reads the other. At right, the President and Mr. Summerfield read their letters, each signed with the elderly chief's thumbprint.

Normally highway post offices do not permit visitors aboard, but officials waived rules on inaugural day and thousands inspected this $72,000 vehicle.

Later I examined in detail a particular phase of mail operation, the adventures of outbound letters brought to the General Post Office for processing and shipment.

From unloading platforms wagons rolled onto a broad mezzanine above the outgoing-mail floor, where workmen emptied bags on tables. I watched clerks sort out airmail and metered letters, then toss them to overhead conveyors bound for other distribution points. They dumped stamped mail into gravity bins, or "hoppers."

Beneath the mezzanine letters tumbled from bins onto "face-up" tables (page 142). Dextrous clerks separated the envelopes by sizes —"shorts" and "longs"—and fed them via still other conveyors to cancellation machines. Here city, date, and time of cancellation were automatically printed.

After cancellation, workmen trundled the letters on wheeled trays to the next process, separation. Pursuing the trays, Mr. McEntee and I walked down long aisles lined solidly with tall wooden cases, each containing dozens of pigeonholes bearing names of geographical locations. Clerks stuffed letters into holes with amazing rapidity (page 141).

"We call this the casing process," Mr. McEntee explained, "and these men are making a primary separation. Look at the names above pigeonholes and you'll see that they are breaking the mail down by States and large cities, sometimes by mail routes.

"Later, much of this mail will go on to a secondary separation. Take New York State letters, for instance. We'll segregate most of them by cities; the rest, for small towns, by routes."

Clerks Take Semiannual Exams

Many sorting clerks, he added, must know complicated "schemes," or plans, for breakdown of mail to certain areas. Frequently they must memorize schedules for mail dispatch from cases to trains and airfields.

"Clerks with those responsibilities are given examinations twice a year," Mr. McEntee concluded, "and they must score 95 percent perfect to pass."

About 30 percent of letters brought to the outgoing-mail section from collection boxes and post office stations are for local delivery. Clerks segregate these letters during primary separation and move them to the "city side," or incoming-mail section.

All post offices, large or small, use cases to separate mail. Obviously the procedure is time-consuming and costly, requiring tens of thousands of clerks. Postal officials constantly seek ways to introduce mechanization in the process.

Chicago has taken a step in that direction with its ingenious Sestak machine. To view it, I followed Joseph C. Schwarz, a senior assistant superintendent, out upon a long balcony where 50 men were casing mail.

I looked in vain for a machine.

"It's below the balcony," Mr. Schwarz said. "But first take a look at those cases."

Not until then did I notice that letters vanished when clerks tossed them into pigeonholes. Closer inspection solved the mystery. Behind each hole yawned a gravity chute.

Letters Borne Like Chips on a Tide

Leaning over the balcony, I could see envelopes drop from the chutes, enter narrow channels separated by metal dikes, and then flow along a conveyor to separation bins, where they were automatically stacked.

"Each channel corresponds to a pigeonhole in one of these 50 identical cases," Mr. Schwarz explained. "Whenever the men throw California letters, for instance, you can be sure those letters will end up downstairs in the California bin.

"Here's the advantage. A man working a conventional case separates an average of 975 letters an hour. But he spends about 12 minutes of each hour cleaning out his pigeonholes and dispatching mail.

"Now take a Sestak clerk. He doesn't have to strip his case, so he throws 1,275 letters an hour. And that really speeds up separation."

John Sestak, a Chicago postal employee, devised the machine and built a prototype from scrap metal, mostly one-gallon fruit cans from the post office cafeteria. As yet, there are only two Sestaks in the entire service, one in Chicago and one in Washington, D. C. (pages 128 and 129).

But postal officials are looking beyond this device. They want a machine that will read addresses and separate mail far faster than human hands and eyes can function.

No, it's not impossible. Deputy Postmaster General Charles R. Hook, Jr., told me:

"In a year or two we expect to have plans for an electronic device that will read typescript and give us a primary separation. Business mail is about 60 percent of first-class

2's and 3's Flow in Endless Ribbons from Government Presses

Each year the Post Office sells 25 billion stamps, all produced in the Nation's Capital at the Bureau of Engraving and Printing.

These new rotary presses, each capable of turning out 3,000,000 stamps a day, Carved plates bearing multiple impressions of a hand-engraved master die print 400 stamps at each revolution.

In flashing streams of color, the valuable web of paper passes over heated drums (top) to dry the ink, then face down under a gumming roller (center) for its coat of stickum. The glue, an edible mixture of cassava and hybrid corn, flows in pipes from near-by vats.

Large denominations—$1, $2, and $5—are printed in sheets on slower flat-bed presses.

Like Thread on Bobbins, Stamps Wind in Coils for Vending Machines

After printing and perforating, postage is cut into sheets for delivery by registered mail to post offices, packaged in pocket-size booklets, or wound into rolls. The rolls, of common denominations, go into automatic dispensers, found increasingly in drugstores and at clear counters.

This Government girl spins a daily average of 1,600 coils of 500 stamps each. Her machine slices thick rolls of postage into 10 strands and winds them on spools.

Cost of production amounts to 1.5 cents a thousand for sheet stamps and 19 to 23 cents a thousand for rolled stamps. In either case the Post Office sells them at face value. Drugstore dispensers, a private venture, may make a penny on each sale.

Photographs by National Geographic Photographer Volkmar Wentzel

volume, and most of it is addressed by typewriter; so we have a promising field.

"But there is no way we can see to develop a machine that will read handwriting. You just can't eliminate the human element entirely.

"If machines should make possible a reduction in employees, it will be done by not filling vacancies. No one will be fired."

Meanwhile, the law requires many big customers of the Post Office to separate much of their second-, third-, and fourth-class mail. Some organizations, among them the National Geographic Society, also help our postmen by breaking down large first-class mailings.

In 1953 your Society dispatched nearly 4.5 million pieces of first-class mail, most of it already separated according to postal specifications. This voluntary work saved the Washington, D. C., Post Office hundreds of hours of labor.

Leaving the Sestak machine, Mr. Schwarz and I sought the parcel post story.

In Chicago's General Post Office building, conveyors lift outbound packages to a seventh-floor processing center. Mr. Schwarz had prepared me for a visit to this center with the laconic comment, "You'll see a few packages."

National Geographic Photographers
J. Baylor Roberts and Donald McBain

National Geographic Photographer J. Baylor Roberts

A Postal Employee's Device Speeds the Task of Separating Letters by Addresses

Clerks normally separate letters by stuffing them into pigeonholes in big wooden cases (page 141). When holes are filled, workers must stop and empty them. John Scotak's machine eliminates this delay (page 126). Above: Washington, D. C., clerks toss mail into slots labeled with States and regions. Opposite page: Envelopes, dropping to another level, flow on conveyor belts through narrow channels to separation bins.

A few! There were an incredible number. They arrived by twin conveyors in a tawny flood high above the floor. At intervals electrically powered board sweeps, shaped like snowplows, pushed gently through the flood. Nudged from the belts, packages slithered down into big storage bins.

Mr. Schwarz pointed to men on a catwalk above our heads.

"They operate the boards, also these bins, or reservoirs. If we're flooded with packages, we hold them here until employees catch up on the volume. Operators can release packages any time they get the word."

Apparently word came, for the doors of several bins swung open like floodgates of a dam. Out streamed parcels to floor-level conveyors.

In the next room 148 clerks made a primary separation of the packages by tossing them into canvas tubs—the parcel post equivalent of letter casing. Boxes flew through the air like confetti in a breeze, but the clerks' aim seemed unerring.

Packages stamped "Fragile" get special handling, as well as the myriad live creatures permitted by regulations: day-old fowl, baby alligators and turtles, honeybees, earthworms, frogs, goldfish, lizards.

All post offices have favorite stories about mishaps to these creatures. In New York clerks recall the time a beehive split open on an unloading platform. Enraged insects dive-bombed everyone in sight until Humane Society exterminators quelled the uprising.

In Chicago a foreman showed me this terse, tongue-in-cheek official damage report:

"We received a parcel, mailed from California to Massachusetts, which contained 30,000 ladybugs. United Air Lines employee states 20,000 were loose in the airplane, but it appears that the parcel had 29,000 left therein when dispatched. Parcel sealed, marked 'Arrived in damaged condition,' and forwarded to destination."

Clerks Have Their Own Language

We were threading our way across the outgoing-mail floor when a big clerk leveled a finger in our direction and boomed:

"Send those bums over here!"

"Seems as if he knows us," I ventured.

"Nope, he wants these," Mr. Schwarz grinned, pointing to a pile of empty mail sacks. "We call them 'bums.'"

Clerks coin many such words and phrases. The "butcher book" is a record of registered letters found in the ordinary mail. When a work area is clear, "the floor's a ballroom." Stamps that fall from envelopes are "sheds."

A Stamp Mosaic Depicts Christ on the Cross

This unusual work of art, created from 4,524 canceled U. S. stamps, hangs at Woodstock College, a Jesuit school in Woodstock, Maryland. The artist, the Reverend Anthony G. Schirmann, S.J., used no crayon or ink, but superimposed variously colored stamps and meticulously adjusted cancellation marks to draw the face and figure. Only two stamps were cut to fit the design. Vertical letters spell *Salus Mundi*, Salvation of the World.

Experts Appraise Rare Stamps

A mecca for stamp collectors, the nonprofit Philatelic Foundation in New York City carries on educational work in philately through lectures, exhibits, and publications. It houses valuable stamp collections, owns a reference library, and authenticates rare stamps. Here Henry M. Goodkind and Mrs. Louise B. Dale, members of the foundation's Expert Committee, examine a collection. Microscope and micrometer help to detect stamp counterfeits.

Improperly addressed letters are "duds," and the men who specialize in deciphering duds are "hard men" or "nixie clerks."

Letters that cannot be readdressed, or returned to the sender, end up in the dead-letter sections of large post offices. Each year approximately 23 million letters and one million packages meet that fate. Unclaimed cash found in these letters, averaging some $100,000 annually, goes into postal revenues; likewise $500,000 from the sale of merchandise.

Invariably the fault lies with the public: improper addressing, no return address, insecure packaging and wrapping.

Whimsical Addresses Deciphered

Fictional detectives seem pale in comparison with nixie clerks. Frequently these postal veterans match wits with wags who address letters in Morse code, in musical notes, by numbers corresponding to position of letters in the alphabet, with drawings, or with chemical symbols, such as H,Otown for Watertown.

Clerks are not required to decipher whimsical addresses, but they often do. Most of their trouble stems from misspelling and poor handwriting.

A nixie clerk showed me his tabulation of 197 spellings of Chicago, among them Chaquechico, Shebego, Zizabo, and Hizago. I saw letters in difficult scrawls addressed to "Tourtle Clock, U.S.A." (Turtle Creek, Pennsylvania); "Poki-hunter, I." (Pocahontas, Iowa); and "Leven Hull, Id." (Twin Falls, Idaho).

Articles spilled from containers and found loose in the mails often give employees their worst headaches. Lester Bricks, a New York official, recalls spending weary days tracking down the addressees for a human eye preserved in a jar of liquid and an urn containing human ashes.

When dispatched mail leaves our post offices, it passes into the vast realm of the Bureau of Transportation, jealous custodian of the time-honored slogan, "The mail must go through." And, come hail or high water, it always does—by aircraft, rail, horseback, bus, truck, ship, dog team—in fact, by just about every means that man can conceive.*

A vast Teletype network links Bureau representatives; if there is a transportation tie-up in one region, orders shoot out all over the country to reroute mail around the trouble.

Within the past year the Bureau has introduced a number of experimental innovations in mail handling, including the dispatch of first-class (3-cent) mail by air at no extra charge. European countries pioneered the practice. The United States followed suit in 1953, linking Chicago with New York City and Washington, D. C. Early in 1954 we added routes between these three northern cities and points in Florida. Recently a number of western communities were included.

The new service supplements, but does not displace, regular airmail. Your airmail letters are guaranteed transportation by plane, whereas the airlines contracted to carry 3-cent mail on a space-available basis. So far, however, they have found room for all the letters.

After World War II the Post Office introduced experimental helicopter airmail delivery in the Los Angeles metropolitan area. Later the Department included Chicago and New York.

Chicago's Helicopter Air Service, Inc., shuttles mail from dawn to dusk, six days a week, between Midway Airport and the roof of the General Post Office (pages 148 and 149). This service also picks up and delivers mail to 32 suburban communities for 52 post offices.

Leapfrogging congestion, the company's fleet of seven helicopters reduces suburban delivery time by as much as 24 hours.

When loaded with mail, the aircraft, all Bell 47-D models, have room only for the pilot. I rode to the post office in a training ship with operations manager Robert Angstadt. Throughout the 9-mile trip we flew formation with a companion copter delivering mail.

Flight Route Follows Canal

Hurdling the airfield fence, we crossed a broad avenue, skirted a housing development, and pinwheeled up to an altitude of 500 feet. In a moment the sluggish, murky waters of the Chicago Sanitary and Ship Canal appeared below. We banked gently and followed the shoreline.

Exposed as in tabletop-scale relief lay the industrial heart of a great city: directly below, a switching yard, its vast expanse neatly ruled with line upon line of freight cars; to our left, the plants of titans, such as International Harvester and Commonwealth Edison; to our right, the pens of Union Stock Yards, a study in cubism.

* See "J. W. Westcott, Postman for the Great Lakes," by Cy La Tour, National Geographic Magazine, December, 1950.

♠ **Pat, the Postman's Horse, Supervises Weighing of a Parcel**

Pat has helped deliver mail six days a week for 12 years, missing only four trips. As a private contractor, the postman receives $160 a month. Postmistress Hazel Mollohan operates the scales in this 8-by-12-foot frame post office at Floe, West Virginia.

♠ Vaughan, completing his route, hands mail to postmistress Garnet Vaughan, a relative by marriage, at her store in Elmira.

♠ **Mail and the Weather Are Hot-Stove Topics in Rural West Virginia**

Deep in the West Virginia hills, J. B. Vaughan delivers mail on horseback to 200 country folk (page 136). His 8-mile route links the little towns of Chloe and Elmira. Like many rural carriers, he is friend and confidant to his "customers." Frequently they depend on him to bring medicine or deliver urgent messages. Here 50-year-old Vaughan distributes mail at the post office-general store in Chloe.

← Near the postman's home, Mrs. Vaughan meets her husband to get the day's newspaper. There's mail, too, for the neighbors.

Soon we passed the busy intersection of Cermak Road and Archer Avenue. Traffic moved steadily but slowly, it seemed, as we sped by at 75 miles an hour!

Now we were very near the post office. Ray Vyskocil, pilot of the other copter, flashed us a broad grin through his plastic canopy, then veered away to drop gently as a falling leaf onto the post office roof. We circled the building and joined him.

"Less than a 10-minute trip," said Angstadt. "About average. If Ray's mail had been brought by truck, it would have taken at least 40 minutes."

Road Carriers Replace Many Trains

Over the past 25 years competition from air and highway transportation forced railroads to discontinue hundreds of passenger trains. Since practically all these trains carried mail, the Post Office faced schedule problems all over the Nation.

It solved them by replacing canceled trains with trucks and busline service. Later the Department introduced highway post offices, big, specially built vehicles fitted out like railway mail cars.

The program has been so successful that officials have canceled mail trains where road carriers gave better and cheaper service.

But, despite such trends, our railroads are still the backbone of the postal transportation system, carrying most of the 160 million pieces of mail which move through the system every 24 hours.

And still an elite group, though reduced in numbers in recent years, are the Nation's 15,000 railway mail clerks, the men who separate much of the first-class mail while it travels. In doing so, they minimize handling time in post offices and speed delivery of your letters.

Rain was slanting down from grimy-looking cloud banks when I reported at the door of a railway mail car in Union Station, Washington, D. C. August W. Bedgar, foreman in charge, lowered a hand and pulled me aboard, bedraggled as a wet puppy.

"Been a member of the National Geographic Society many years," he said. "Catch your breath, then look around, meet the others. We're a 6-man crew today because of the Christmas rush. Normally these cars carry four men."

I had never been aboard a railway mail car, but it looked familiar, very much like the outgoing-mail section of a small post office. At one end letter cases lined the walls. In the center, bolted to the floor, stood a long face-up table, flanked by mailbags hanging from racks and metal bins suspended from the ceiling. The other end of the car served as storage space.

Mr. Bedgar and his men carried snub-nosed .38-caliber pistols. I hoped I had come aboard with sterling character references!

Our train, bound for Jersey City, New Jersey, started with a lurch that sent me ricocheting from a wall. As we gained speed, I marveled at how easily the clerks maintained balance.

"Ever see how mail is picked up by a moving train? Better join Bob Pimm at the other end, or you'll miss it," the foreman suggested.

Bob, at 26 the youngest man aboard, pointed to a big iron hook hanging from a bar in the doorway.

"We call it a catcher arm," he said. "When we make a pickup, I open the door and stick the arm outside. Pretty soon, whammo! I've got me a mailbag! Catch it on the fly from a crane beside the tracks."

He glanced casually through a window. "Hyattsville, Maryland. That's my signal."

Bob donned a pair of goggles, slid the door back, looked out, paused, tossed a mail sack through the door with his left hand, and swung the catcher arm with his right. Suddenly a loud *thwack* filled the car, and the arm held a mailbag. Grinning broadly, Bob drew it inside.

Specialists Sort Big-City Mail

Other clerks kept busy at sorting tasks. Mr. Bedgar separated mixed mail for mid-Atlantic and New England cities. G. L. Ford worked Pennsylvania letters. John Bosley specialized in a fine separation of New York City mail by zones and postal stations; H. L. Krieger had the same task for Philadelphia.

In the center of the car Harvey Kushner and Bob Pimm separated letter mail, taken aboard with the catcher arm, and newspapers.

As each clerk completed a separation, he tied his mail in bundles and gave them to Mr. Kushner, who tossed them into mail sacks labeled with points of destination. By the time we reached Jersey City and goodbyes were in order, all the 150 bags of mail taken aboard had either been distributed at stops or segregated for further routing.

Government Artist Designs a Stamp from National Geographic Illustrations

Charles R. Chickering combined a photograph of cacti from the April, 1937, NATIONAL GEOGRAPHIC MAGAZINE and a wagon train picture from the June, 1940, issue for the 1953 Oneidden Pathfinder stamp (under glass). Earlier design (right) was rejected.

Crime Lab Technician Analyzes Ink Used in Addressing Poison Candy

This valentine, containing enough rat poison to kill hundreds of people, was mailed in a murder attempt. A postal employee analyzes the ink on the mailing label as one step in tracing the sender. Handwriting analysis (right) helped convict the guilty person.

Highway post offices—"hypos" in Department parlance—offer several advantages over their railroad counterparts. They are cheaper to operate. They go directly to post offices, saving the time and cost of hauling mail from railroad stations. And, unlike passenger trains, they run on schedules established by the Post Office to suit its convenience.

The first HPO route, between Washington, D. C., and Harrisonburg, Virginia, dates from 1941. Since then the number has grown to 123. In many areas, particularly in the West, communities celebrate the inaugural day of a highway post office with speeches, parades, and band music.

National Geographic photographer Volkmar Wentzel and I witnessed such a celebration last winter when the Department opened a highway post office route between Philip and Sioux Falls, South Dakota (page 124). Little Philip (population 810) arose en masse at dawn to see guests and postal officials aboard the bus. But first, leading citizens plied us with a breakfast embarrassing in its bounty.

Cowboys and Indians Greet the Bus

We drove in near-zero weather through endlessly rolling prairie, sere from the hand of winter. Crowds welcomed us at each rural town. Whooping cowboys milled about on horseback. Indians in full regalia extended greetings from the Sioux tribe. High-school bands blared bravely, though lips froze to instruments. Little drum majorettes pranced in scanty costumes, their teeth chattering like telegraph keys, their limbs a glacial blue. But they wouldn't quit!

I was most impressed by the obvious gratitude of the townsfolk for their new service. They had come from miles around to see the gleaming bus. It was on exhibit at each stop, and people filed through its 35-foot length, staring, exclaiming in awe. Told it would speed mail delivery 12 to 24 hours, they shook hands with officials and smiled their thanks.

Often the mayors and postmasters of various towns rode with us for a stop or two. On one leg of the trip the bus carried 18 jovial, chattering passengers, and clerk Arthur Peirce had difficulty finding elbow room while separating and canceling mail.

All of us scribbled letters, using the backs of fellow passengers as writing desks. Mr. Peirce sold us stamped envelopes bearing a special cachet, or imprint, which outlined South Dakota's boundaries and showed the route of our bus. Such envelopes, known as "first day covers," are prized by collectors.

Some areas of the United States defy motorized transport of the mail. Even Philadelphia still has a few horse-drawn mail carts; they prove more efficient in narrow, congested streets. But usually old Dobbin carries postmen over rough routes in out-of-the-way places.

Just such a route, eight rugged miles long, connects the tiny towns of Chloe and Elmira in the hills of central West Virginia. There 60-year-old J. R. Vaughan, astride his pinto horse, Pat, delivers mail six days a week to about 200 hill folk (page 132).

Contractors Operate "Star" Routes

Burt, as he likes to be called, is not a regular postal employee. He operates a "star," or contract, route.

Postal contracts admonish private carriers to transport the mail with "celerity, certainty, and security." Many years ago clerks, tired of copying the repetitious phrase, fell into the habit of drawing three stars to indicate the words; hence, star routes.

Today there are more than 12,000 star route contractors. Some operate large enterprises with fleets of motor vehicles; others, like Burt, work alone, doing jobs that would be uneconomical for the Post Office to undertake with regular employees.

Most farmers, however, receive their mail via Rural Free Delivery, a Department service employing more than 32,000 regular carriers who serve approximately nine million families.

Volkmar Wentzel and I rented horses one winter's morning and rode with Burt along his route. The wind blew gently and warm, hinting at an early spring, and the route wound pleasantly along the base of a wooded ridge.

But the condition of the dirt road tempered our delight in the weather. Thawing snow and ice had turned the red earth into gumbo, so slippery that our horses had difficulty with their footing on the slopes. Wheel ruts indicated automobile traffic, but before long the route became all but impassable for motor vehicles. Most back-countrymen, Burt said, walked or rode horseback.

We passed several comfortable frame homes. Later, as the road steepened and the hills moved in, dwellings became small and weath-

(Continued on page 145)

Kodachrome by National Geographic Photographer David S. Boyer

A Coin-fed Robot Stamps, Postmarks, and Mails Letters for Post Office Customers

Mailomat takes the patron's money and registers the amount in the window above her hand. Then the machine whisks away her envelope, prints the amount of postage she has dialed, postmarks city and date, and deducts the cost of each letter from her deposit. This Mailomat, installed in the lobby wall, ejects letters directly into the Washington, D. C., Post Office. Fifty-eight other machines are scattered across the country.

Experimental Mail Trucks Rouse Curiosity in Miami

Last fall, gaily painted little trucks bearing the label "U. S. Mail" appeared on the streets of eight southern cities. Some looked like overgrown scooters; others resembled jeeps or diminutive milk-delivery trucks. All were being tested by foot-weary postmen.

On wheels a carrier can cover 20 percent more territory than when afoot, and he can handle parcel post, normally delivered separately.

At Miami, Florida, postmen have tested 14 kinds of vehicles. Here sidewalk strollers admire the scooterlike Truckster. Later models have plastic roofs and sides. Parked alongside is a paneled Mailster. Eventually these and other experimental vehicles will be in widespread use, improving home delivery and cutting costs.

Miami processes all its mail in this handsome new annex.

✦ This Mailster wears the national colors, now replacing olive drab on mail trucks. Experiments are being conducted with red, white, and blue paint for metal mailboxes, and with plastic boxes that will need no painting.

Opposite, lower: Visitors examine models of old U. S. mail vehicles at the Smithsonian Institution, Washington, D. C. Wagon and cart represent types in use until about 1910. Stagecoach dates back more than a century. The postal horns are European.


U.S. MA
U.S. MAIL


U.S. MAIL
RURAL MAIL BOX

† Clerks Change the Date on Hand Stamps While Cherubs Carol

Despite the heavy strain of holiday mail, no Scroogelike attitude toward Christmas prevails in the New York Post Office. Tired clerks cheerfully work off-duty hours and spend their own funds to decorate the premises. They used washable paint to create this window scene. These men are replacing numerals in cancellation dates, a daily chore involving hundreds of hand stamps.

✦ High-speed machines cancel stamps on most first-class mail, but bulky items, called "slugs" by clerks, must be imprinted by hand. This collection at the Washington, D. C., Post Office includes souvenir greeting cards, a hotel key, film, and containers of medicine.

A Mechanical Clerk Gulps Coins and Ejects Stamps →

This vending machine supplements stamp window service. It sells 1's, 2's, and 3's, automatically grinding out stamps as coins are inserted. Unlike private machines, it makes no profit on the sale (page 127). The Department owns 1,500 of these units, installed in lobbies of big city post offices.

↓ Christmas Mail Clogs Pigeonholes

Skilled from long practice, clerks toss envelopes into these holes with astonishing speed and accuracy. Here New York City employees sort mail addressed to Indiana, using pigeonholes labeled with names of Hoosier communities. At regular intervals the clerks "strip" their wooden cases and dispatch letters to trains. The women, post office secretaries, double as mail clerks during the holiday rush.

Color photographs by National Geographic Photographers
Volkmar Wentzel and Donald McBain


AIR MAIL

↑ A Paper Blizzard Litters an Airmail "Face-up" Table

The average letter delivered to your door has been handled 11 times.

One of the earliest steps—shown here in the New York Post Office—is the "face-up." Clerks drop standard-size envelopes on edge into a deep gutter encircling the table (hidden by the brown rim). Conveyors whisk the letters to canceling machines.

Labeled bins hold mail culled out for special processing elsewhere. Two clerks toss envelopes onto a pile of "slugs"—letters too bulky or bearing too many stamps for machine cancellation.

Stamp Collectors → Browse at Gimbels

Youngsters rub shoulders with millionaires in this huge stamp center operated by Gimbel Brothers department store in New York City. Customers may choose any of 100,000 separate items, including a new 3-center issued only the day before; the world's first adhesive postage stamp, issued in 1840; a rare 24¢ U. S. airmail costing $4,250; or stamps once owned by President Franklin D. Roosevelt or ex-King Farouk of Egypt.

erbeaten, usually with unpainted board siding and tin or tar-paper roofs.

Occasionally Burt dropped letters in roadside boxes. Shaggy Hereford cattle grazed in narrow fields, but we saw few people.

Riding at a leisurely walk, Burt talked about his work:

"Had this route 13 years; I've ridden Pat the past 12."

Did he ever bring in medicine for these people?

"Sometimes. Usually castor oil or Epsom salts. Anybody gets real sick, they take 'im out to the hospital, but mostly they do their own doctorin'.

"Somebody dies, I often carry word out to the undertaker. I'm in a quartet that sings at all the funerals. Those days I hire a man to deliver the mail for me."

Did he carry messages if people put them in their boxes?

"Well, if it's important, I'll take a note up the road. But I don't let 'em seal it—against postal regulations. . . .

Mail-order Catalogues Add Weight

"Dread mail-order catalogues. They all come on the same day, seems like, and they're awful heavy. Pat can only carry 47 pounds of mail in these saddle bags."

We delivered letters at two 1-room elementary schools, where children greeted Pat like an old friend, and then climbed a 1,500-foot ridge. Here the narrow route could hardly be dignified by the word "road." Woodland enclosed us; not a field or home lined the way. It seemed as if we were in another age, delivering mail through the backwoods of a still youthful nation.

Indian-file, the three of us wound down to Elmira (one house and a post office-general store) and then retraced our route. Unused to riding, I felt as if I were astride a dull razor. But Wentzel, to my chagrin, sat his horse in comfort all the way back to Chloe.

← **Mail Drops from the Sky to a Lonely Florida Outpost**

A Coast Guard helicopter dangles mail on a cable above Fowey Rocks Light, 14 miles from Miami. In good weather a cable trip releases the bag onto the lighthouse's upper balcony; here strong winds make a close approach dangerous, and seamen receive the mail drop from a small boat (inset). The light, 110 feet above water, is visible for 14 miles.

© National Geographic Society

Kodachrome by National Geographic Photographer Robert F. Sisson

Returning to Washington, I called upon the Bureau of Facilities, housekeeper extraordinary, which provides logistic support for the armies of clerks and transportation employees. This Bureau manages approximately 3,200 Federally owned post offices, spends $37,000,000 a year for rental of space, services the huge fleets of motor vehicles, and buys everything the Department uses. Purchases may range from a lock part $\frac{1}{10}$ of an inch long to a conveyor system two stories high and the diameter of a city block, such as the one at Cleveland, Ohio.

Many Post Offices Are Outmoded

But the Bureau's biggest headache-inducing job lies in the acquisition and management of real estate. Congress has not appropriated funds for construction of new post offices since 1958. Meanwhile, the Department has grown too big for its plants. Most main post offices in the Nation's 27 largest cities were built between 1908 and 1939, and all, our postal officials say, are now inadequate. At times mail must be stacked on platforms and sidewalks because there isn't room inside.

When new quarters must be constructed, the Department induces private capital to foot the bills, then leases the properties, often for 20 years. Officials prefer this method to Federal construction, and say it's cheaper.

The Bureau of Facilities has developed plans for a standardized ultramodern post office building. A research program is under way to determine the best places to put these new structures. Present thinking inclines to the use of small downtown post office stations for the convenience of the public, with processing centers in less congested areas.

The problem of bulk mail handling, both here and abroad, is relatively recent, dating from a successful fight for cheap postage waged on a world-wide scale in the 19th century. But the post, as an institution, goes back to ancient times.

China's dynasties employed relay runners more than 2,000 years ago. Ancient Greece and Rome used couriers, as did the Inca and Maya Empires. The Bible contains references to a postal system: King David's letter ordering the death of Uriah; Jezebel's message that caused the murder of Naboth; Job's lament, "Now my days are swifter than a post: they flee away."

The Persians' courier system, which excited the admiration of Herodotus, seems to have

been the model for other posts, including that of the Egyptians.

These communication systems, and many that followed, were for the use of rulers, not the public. In medieval Europe, cities, merchant guilds, even universities set up their own posts. Gradually, however, governments took over private ventures.

Sending or receiving a letter was fraught with chance in America's early colonial years. Travelers and servants carried messages. Shipmasters, if so disposed, would take letters to England. They dumped return mail on the tables of coffeehouses; addressees, if lucky, got word of their letters and claimed them.

Several Colonies organized their own posts, but it was not until 1693 that an intercolonial system under English auspices came into being. Service was poor and rates were high. Many colonists evaded the monopoly by using private carriers.

Ben Franklin Improved Mail Service

In 1753 Benjamin Franklin won appointment as joint Deputy Postmaster General for the Colonies. He increased the number of posts, introduced stagecoaches, started a packet service to England, and put the service on sound financial footing. Franklin lost his job prior to the Revolution and took on the organization of a postal service for the Revolutionary forces. Where before he had franked his envelopes with the words, "Free B. Franklin," he now wrote, "B. Free Franklin."

Samuel Osgood, first Postmaster General under the Constitution, employed a mere 75 postmasters when he took office in 1789. Eleven years later, when the Department moved to Washington, D. C., it had only nine men in its headquarters.

But the Post Office grew enormously as a restless people pushed toward the western sea. With growth came many innovations. In 1847 we began licking postage stamps, first introduced in England seven years previously. The registry system was born in 1855. Three years later we obtained street letter boxes and, in 1863, free city delivery.

Other new services followed: money orders, 1864; postal cards, 1873; special delivery, 1885; rural free delivery, 1896; postal savings, 1911; parcel post, 1913; airmail, 1918.*

Meanwhile, a new organization, the Universal Postal Union, undertook a quiet revolution in the international field. Organized in 1874, the Union bound 22 nations, including the United States, in an agreement to forward members' mail at standard transit rates. Actual delivery of foreign letters within member states would be free. This was a tremendous step, for previously international mail had been subject to a hodgepodge of restrictive treaties among individual nations.

Today the UPU serves every country on the face of the earth. A specialized agency of the United Nations, it maintains headquarters at Bern, Switzerland, where technicians assist members in amicable settlement of bills and disputes. At least once each five years, nations meet to revise their time-tested agreement.

Letters Free To Go Anywhere

You benefit enormously from the work of the Union. Your letters to other countries can go anywhere, free of the passports and visas which restrict human travel. You prepay the message with a stamp, and the Post Office reimburses other nations for transit charges en route.

There is, however, one aspect of our own postal history in which no one takes pride.

During the past 115 years of operation your Post Office has been out of the red only 18 times. Deficits since World War II total a staggering $3,800,000,000. The interest alone on this sum costs taxpayers more than $100,000,000 a year.

Obviously the stamps and services we buy do not pay the cost of mail handling. But there is wide disagreement regarding which, if any, rates should be raised, and how much.

At this writing Congress is weighing the rate question while considering a Department proposal that would hike fees all along the line.

Postmaster General Summerfield believes his budget could, and should, be balanced, and he has taken a number of preliminary steps in that direction.

Several fees were raised by administrative action. Congress voted that its members, as well as Government bureaus, should pay for their mail instead of posting it free. Subsidies for airmail carriers were transferred from the Post Office to the Civil Aeronautics Board.

These steps, plus multimillion-dollar economies, have had a salutary effect upon Department finances. The deficit for the fiscal year ending June 30, 1954, had been esti-

* See "Aviation Looks Ahead on Its 50th Birthday," by Vice Admiral Emory S. Land, USN (Ret.), National Geographic Magazine, December, 1953.

mated at $746,000,000. Department officials now believe the red-ink figure will be about $400,000,000.

This is still far too high, Postmaster General Summerfield says. If proposed rate increases are granted, he thinks the deficit can be cut to less than $100,000,000.

Efficiency Cuts Costs

Meanwhile, the Department has moved to cut costs through greater operating efficiency. A new Bureau of Personnel is initiating modern safety, recruitment, and training programs. Operations has begun the task of decentralizing post office supervision. Work standards and streamlined accounting procedures have been devised.

To speed service, officials ordered later collection and window hours in major cities, introduced experimental stamp-vending machines at post office windows, and undertook a program for the development of more efficient light vehicles (page 138).

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National Reasonable Postmaster David B. Bess

An Envious Postman Eyes His Friend's New Cart

Recently the Post Office bought 500 of these collapsible carriers and distributed them around the country for experimental use in home delivery. Made of aluminum, they can be pulled like caddy carts or pushed like baby strollers. Postmen often leave them overnight in mail-storage boxes.

The Department even tried to do something about scratchy post office pens. As an experiment, post offices in Washington, D. C., and near-by Maryland bought handsome ball-point models and chained them to lobby desks. But within a week the shiny new pens disappeared, torn from their moorings. The venture was written off as a noble failure.

Our Post Office Department, no matter how intricate its financial problems, can always count upon one sure money-maker, the Division of Philately.

Philately, or stamp collecting, is the most universal of hobbies (pages 130 and 143). The United States alone has an estimated 12 million collectors. Many are steady customers of the Division's Philatelic Agency in Washington, D. C., where current stamps are sold by mail order or at counters. Agency sales exceed $2,500,000 each year. No one knows how many stamps collectors buy at post offices, but officials delight in speculating that it must be a very large number.

Philately Yields a Tidy Profit

"You see, we realize about 85 percent clear profit from philatelic sales," beamed Robert E. Fellers, head of the Division of Philately. "Most of the stamps go into albums. Since they aren't used as postage, no mail service is performed by the Department and we save money."

Hobbyists take special delight in acquiring commemorative stamps, issued each year to honor organizations or to observe historic events. For example, the 1953 output included stamps for the tercentenary of New York City, the 50th anniversary of powered

A Magic Carpet Picks Up Mail at a Chicago Airport

City congestion, bane of earth-bound mailmen, is no problem for pilot-postmen of Chicago's Helicopter Air Service, Inc. Using seven Bell 47-D copters, this private business shuttles mail between Midway Airport and the General Post Office roof, an 18-mile round trip, and serves 57 suburban post offices as well (page 131). Dawn-to-dusk flights keep airmail moving on a strict timetable six days a week.

Below, left: Nine minutes after leaving the airport's mail terminal, the aircraft delivers its 500-pound cargo and takes on an outgoing load on the Post Office roof heliport.

Speeding the Mail, the Copter Leapfrogs Across a Mighty City

The "whirlbird" below flutters away from the Post Office roof (lower left) southwest of Chicago's congested Loop district. The pilot need not hurdle skyscrapers; over most of his route he follows the Sanitary and Ship Canal.

Since organizing in 1949, Helicopter Air Service has flown 115 million miles and carried more than 15 million pounds of airmail. Despite the bluster of Windy City weather, pilots meet 98 percent of their schedules.

➔ Back at Midway, unmindful of snow that clogs streets, the copter takes aboard air parcel post.

150 U. S. Marine Corps, ocmail

An Expert Loads a Marine Mailman's A-frame in Korea

For centuries Koreans have back-packed staggering loads on wooden A-frames, so named for their shape. This mail orderly, bent by Christmas parcels for Marines, adopted the technique and sought a farmer's help in adjusting his load. During 1953 Americans sent 121 million pounds of mail to servicemen overseas. The Post Office delivered this mail to embarkation points for transport abroad by military ships and aircraft.

flight, and the 150th anniversary of Ohio's statehood. Among organizations honored were the National Guard, the American Bar Association, and the Future Farmers of America.

Stamp Honors Alexander Graham Bell

Memorial stamps honor individuals. Collectors prize in particular a 1940 series featuring 35 famous Americans, among them Alexander Grahm Bell, inventor of the telephone and president of the National Geographic Society from 1898 to 1903. His portrait appears on a 10-cent stamp.

Recently President Eisenhower dedicated a new 8-cent stamp, the first regular issue to bear the words "In God We Trust." Postmaster General Summerfield ordered the design.

"Stamps should stimulate thinking," he comments. "They represent the United States to people all over the world. Why shouldn't they be symbolic of what this Nation stands for?"

He would also like to make them multicolored and more attractive.

At present all United States postage stamps are printed from steel plates bearing the impression of a hand-engraved master die. I saw this process at the Bureau of Engraving and Printing in Washington, D. C.

But hand engraving limits stamps to one and, occasionally, two colors. Rotogravure, a photochemical technique, permits four colors. The Postmaster General has asked the Bureau to experiment with rotogravure stamps.

Years ago a dubious public referred to stamps as "Government sticking plasters," and loud were the ughs of distaste when tongues licked the unpalatable glue. Today that glue, a mixture of cassava and hybrid corn, is not only palatable but mildly nutritious.

Workmen brew the rust-red mixture in huge copper vats. After thorough stirring and hours of simmering, it is piped off to the presses. There I watched gooey rollers uncoat the stamps (page 127).

D. C. Tolson, superintendent of the Bureau's stamp division, was rather apologetic when he led me into his big vault.

"Only have about $165,000,000 worth in here," he said, gesturing at the ceiling-high mounds of stamps. "Our stock's depleted at the moment!"

The sight of so much wealth reminded me of a comment by the Postmaster General on the difficulty of counterfeiting stamps.

"There has been a lot of public speculation to the effect that rotogravure, because it is a

Shoppers Examine "Dead" Parcel Post Offered for Sale

Each year dead-letter offices reap an unwelcome harvest—24 million letters and a million packages, all undeliverable (page 151). Usually senders gave wrong addresses, failed to include their own, or did a poor job of packaging. Every three months large post offices sell an amazing assortment of dead merchandise, ranging from dime store gimcracks to sterling silver dinner pieces.

These buyers scout for bargains prior to a New York City auction. Tubs hold bulk lots.

Leo Hetzon, International

A Clerk Identifies Stolen Wallets

Pickpockets, after rifling a wallet, usually drop it in the nearest mailbox to get rid of embarrassing evidence. New York City boxes yield an average of 80 wallets a day; all are sent to this desk. Usually thieves do not remove identification cards, and clerks trace the owners. Occasionally a man carrying large sums of money who fears he is being followed by thugs will drop his billfold in a mailbox. Such wallets, too, are promptly restored.

photoengraving process, could be duplicated easily by counterfeiters," he said. "It's true that hand engraving, which is distinctive, offers more security, but the new method definitely would not be easy to imitate.

"What's more, postal inspectors would detect counterfeits immediately. Like Canadian Mounties, they always get their men."

And convict them, he might have added, for inspectors successfully prosecute 97 percent of the cases they bring into court (page 135).

The inspection service is the oldest investigative agency of the Federal Government. In fact, it's older than the Nation. Ben Franklin was the first inspector, although he called himself a "surveyor of the post."

Today the service has more than 900 inspectors. All, including Chief Inspector David H. Stephens, rose from the Post Office ranks through special competitive examinations. The men receive training in criminology and other fields before being assigned to districts.

One branch of the organization solves administrative problems. Inspectors given this type of work might be called efficiency experts. They install, instruct, and rate postmasters, inspect offices, make management surveys, organize delivery service, and ferret out the causes of mail delay or damage.

But the service is best known for its "whodunit" sleuthing, largely the province of the investigative branch. Inspectors must cope with a wide variety of crimes: mail fraud and theft, post office burglaries, the mailing of bombs and poisons, forgery, counterfeiting, armed robbery—the list is endless.

Solicitor Aids Postal Inspectors

The Office of the Solicitor backs up inspectors in bringing criminals to justice and in purging from the mails material that is obscene, subversive, or defamatory.

Five modern crime laboratories assist postal detectives in their work. Stocky Albert Somerford, in charge of the Washington, D. C., laboratory, has nabbed many criminals without setting foot from his office.

He showed me a few tricks of the trade as we thumbed through typical cases from his current file. For example:

A thief had smashed a small post office safe, apparently with an ax. Inspectors had taken into custody a shady character who owned a suspiciously dull ax, but they wanted proof.

Somerford handed me two magnified photographs. One showed every chip and nick on the cutting edge of the suspect's ax. The other revealed that those chips and nicks matched impressions left on the safe.

"This proves that the suspect's ax did the dirty work," said the lab head. "It clinches our case."

Next he showed me a money order.

"It's been 'kited'—raised in value. Numbers were erased, others substituted. Do you see the erasure?"

I didn't—not until he gave me enlarged photos of the numerals. The erasure looked like an eroded gully in the magnified grain of the paper.

We inspected counterfeit stamps. They seemed genuine, but under a microscope the engraved lines appeared tentative, not nearly so bold as in Government-printed postage.

Somerford displayed other tools of his trade: lie detectors, an ultraviolet lamp for observing laundry marks, samples of every ink manufactured in the United States, handwriting specimens, apparatus for soil analysis—these and a host of others.

Laws Protect Sealed Letters

Today, in postal as well as in political matters, there is a gulf as wide as the universe between Communist nations and the Free World.

In the darkened lands behind the Iron Curtain few people dare put in a letter their frank thoughts, their fears and hopes.

But in our own land your sealed letters enjoy the same legal status as the personal papers you retain in your home. Both are guaranteed against unreasonable search or seizure. They cannot be opened and examined without legal warrant.

Perhaps the democratic function of our postal service is best summed up by this inscription on the City Post Office building in the Nation's Capital:

MESSENGER OF SYMPATHY AND LOVE
SERVANT OF PARTED FRIENDS
CONSOLER OF THE LONELY
BOND OF THE SCATTERED FAMILY
ENEMIES OF THE COMMON LIFE

CARRIER OF NEWS AND KNOWLEDGE
INSTRUMENT OF TRADE AND INDUSTRY
PROMOTER OF MUTUAL ACQUAINTANCE
OF PEACE AND OF GOODWILL
AMONG MEN AND NATIONS

That, in essence, is your Post Office Department, the everyday servant to whom an old saying pays this tribute:

"As long as there are postmen, life will have zest!"

Gen. George Marshall Leads Trustees in Spontaneous Tribute to a Staunch Leader

After piloting the National Geographic Society's voyages, both scientific and literary, for more than 55 years, Dr. Gilbert Grosvenor requested retirement on May 5 as President of The Society and Editor of its Magazine.

Portrait of Alexander Graham Bell, The Society's second President, looks down on this historic occasion as General of the Army George C. Marshall reads the Trustees' resolution honoring the retiring President. When Dr. Bell engaged the young Grosvenor in 1899, The Society's membership numbered 900; today it totals 2,150,000.

Here, in his familiar seat at head of the table, Dr. Grosvenor presides over the Board of Trustees. To his left: Robert V. Fleming, Treasurer; Thomas W. McKnew, Secretary; Charles F. Kettering, Director, General Motors Corporation; Rear Admiral Richard E. Byrd, U. S. Navy, retired; Alexander Wetmore, Research Associate, Smithsonian Institution; Rear Admiral L. O. Colbert, U. S. Coast and Geodetic Survey, retired; Hugh L. Dryden, Director, National Advisory Committee for Aeronautics; Lloyd R. Wilson, former Chairman of the Board, Chesapeake and Potomac Telephone Companies; John Oliver La Gorce; Leroy A. Lincoln, Chairman of the Board, Metropolitan Life Insurance Company; Ernest E. Norris, retired President, Southern Railway System; William E. Wrather, Director, U. S. Geological Survey; Vice Admiral Emory S. Land, U. S. Navy, retired, former President, Air Transport Association; H. Randolph Maddox, Vice President, American Telephone and Telegraph Company; Melville Bell Grosvenor; Lyman J. Briggs, Director Emeritus of the National Bureau of Standards; and General Marshall.

tion. The photographs were the first of Tibet's capital and were so extraordinary that I decided to use them to fill the 11 pages (page 65F).

"When I went home, I told my wife that I expected to be fired for filling 11 pages with pictures. No magazine had ever done such a thing. But my anxiety was soon dispelled by members of The Society stopping me on the street to advise me how much they had enjoyed the first photographs of romantic Lhasa. Several days later I was elected to the Board of Managers, now the Board of Trustees.

"In February my cousin, William Howard Taft, then Secretary of War, told me that the War Department was publishing in April (1905) the first Census Report of the Philippines, illustrated with many photographs; and he added that the National Geographic Society could help the Government and the people of the Philippines if I told the members of The Society about this interesting publication. At my request, Mr. Taft instructed the Census Director to lend The Society the copper plates of any pictures in this magnificent report that I desired to reprint in the National Geographic Magazine.

"I selected 32 full-page plates for the April, 1905, Magazine. At that time we had not sufficient money to engrave 32 plates. That Philippine number brought a flood of new members, so many that I had to reprint the issue. Our membership soared from 5,000 in January to 11,500 in December, a gain of 130 percent.

Dr. La Gorce Becomes Assistant Editor

"In September of that eventful year (1905) I advised the Board that The Society had enough money in the bank to relieve Alexander Graham Bell of the $100 per month he had been contributing to the National Geographic Society, from April 1, 1899, to December 31, 1904. And in the same month I engaged John Oliver La Gorce as Assistant Secretary and Assistant Editor.

"When Dr. La Gorce joined the staff of The Society, it was a small organization of only 10,000. But his responsive nature and keen intellect recognized the possibilities ahead for The Society, and his generous heart was stirred to identify his life with a work that promised to promote effectively the welfare of mankind.

"With everything The Society has done since, he has been identified. Many of our useful and interesting projects he originated. He has labored with love and ceaseless energy to help develop the organization and bring it to the dignified position it now holds in the life of our country. His unselfish devotion and loyalty for 49 years have given me the inspiration of a wonderfully happy friendship.

"I was pleased to advise the Board in 1907 that we had enough surplus above expenses to begin annual appropriations for geographic research. The Board made the first grant, $1,000, to assist Comdr. Robert E. Peary, USN, to discover the North Pole.

"The November, 1910, number marked another milestone for The Magazine when I ran 24 pages of photographs in natural color. No magazine had ever printed so much color in one issue. From that day to this the National Geographic Magazine has led all periodicals in the quality and number of its color illustrations.

"When in 1920 I was elected President of the National Geographic Society, I recommended Dr. La Gorce's election to the Board of Trustees and as Vice President and Associate Editor.

"And, on the advice of Mr. Taft and Treasurer John Joy Edson (1901-1935), I immediately arranged for the reincorporation of The Society, so that, instead of a Board of Managers elected annually, The Society is protected by a Board of Trustees elected for life.

Melville Bell Grosvenor Joins Staff

"In 1924 my son, Melville Bell Grosvenor, graduate of the United States Naval Academy, elected to join the National Geographic staff. He has proved an alert, indefatigable, and gifted editor, and in his 30 years' service he has contributed greatly to the progress of The Society and its Magazine. Beginning as illustrations assistant, he served in every editorial department. Many features of the National Geographic Magazine as we know it today are his creation.

"In the absence of the Editor and Associate Editor in travel and on vacation, Melville Grosvenor has had direct charge and responsibility for the make-up of The Magazine. As Senior Assistant Editor he has picked and trained an able group of young editors, writers, photographers, and cartographers. Thus I have been favored 30 years by the presence of a strong son beside me.

"Nine Presidents of the United States, from Theodore Roosevelt to General Eisenhower, have honored the National Geographic Society by taking part in its proceedings.

"I can never find words to tell you gentlemen how grateful I am to you, and to all past members of the Board, for giving me the opportunity to serve the National Geographic Society for so many years, and for your many personal kindnesses to me. I have enjoyed immensely working with you, but now Mrs. Grosvenor and I, with regret, feel that the time has come for me to retire from the strenuous responsibilities of the President and of the Editor of the National Geographic Magazine.

"The membership total of the National Geographic Society today is the largest in the history of The Society—2,150,000. The finances are in excellent condition, and the resources of The Society stronger than they have ever been.

"The ranges of The Society's exploration and research projects are many, extensive, and important. The National Geographic Magazine

650 National Geographic Photographer Willard R. Culver

Dr. Grosvenor Congratulates Dr. La Gorce on His Election as President and Editor

"Dr. La Gorce has labored with love and ceaseless energy to help develop The Society to the dignified position it now holds in the life of our country," said Dr. Grosvenor as he turned over his duties to his associate of nearly half a century. Dr. McKnew, Secretary (left), Dr. Fleming, Treasurer, and Dr. Melville Grosvenor, new Associate Editor and Vice President of The Society, share the occasion.

is becoming more interesting and worth while every month. The Society has a competent staff in every department. I am confident they will carry The Society ever onward.

"In Dr. Robert V. Fleming, Treasurer since 1935, and Dr. Thomas W. McKnew, Secretary since 1945, The Society has two officers of wide experience. Dr. Fleming is President and Chairman of the Board of the Riggs National Bank, a Director of the Metropolitan Life Insurance Company and Pan American World Airways, past President of the American Bankers Association, etc., but he always has time to give to National Geographic affairs careful attention and the benefit of his vast knowledge. Dr. Fleming has visited many countries and would qualify as a top GEOGRAPHIC editor because of his quick grasp of human interest.

"Dr. McKnew, my companion to the North Pole, conducts the vast correspondence with our millions of members with the courtesy and efficiency that have won many friends and new members. His department, with new electronic devices for simplifying and perfecting the voluminous billings and records for 2,130,000 members, is without peer in any publishing organization in the world. He has studied geography on every continent.

"I respectfully recommend that the Board of Trustees elect Dr. John Oliver La Gorce President and Editor.

"With affectionate regards from Mrs. Grosvenor and myself, I am

Very sincerely,

GILBERT GROSVENOR."

General of the Army George C. Marshall then offered the following resolution:

"Resolution Adopted by the Board of Trustees, National Geographic Society, at a Meeting Held May Fifth, Nineteen Hundred and Fifty-four.

"TO GILBERT GROSVENOR, Editor, Geographer, Educator, Scientist, Writer, Business Executive, and Financier by Vocation; Ornithologist, Naturalist, and Photographer by Avocation

GREETINGS

BE IT RESOLVED:

"WHEREAS, on this day, Gilbert Grosvenor has by his own election laid aside his heavy responsibilities as President and Editor after more than fifty-five years of leadership of the National Geographic Society and its Magazine;

"AND WHEREAS the Board of Trustees at its meeting today has created the office of Chairman of the Board and has unanimously elected Gilbert Grosvenor to that office, the Board desires to record this, its spontaneous tribute to Gilbert Grosvenor the Editor and to Gilbert Grosvenor the Man.

"WHEREAS, on April 1, 1899, when Gilbert Grosvenor was engaged to increase the membership of The Society, its total members numbered nine hundred and its net worth was a deficit figure. Gilbert Grosvenor forthwith proceeded to build The Society into the paramount force it is today in the spread of geographic knowledge, with two million one hundred fifty thousand members in all parts of the globe. He built for The Society the solid foundation upon which rest its strength and influence today.

← **With Gigantic Kites, Alexander Graham Bell Probed the Riddle of Flight**

Dr. Bell was confident years before planes first flew that man could get into the air. At his Baddeck, Nova Scotia, laboratory, he flew huge tetrahedral kites in attempts to develop a new type of heavier-than-air machine that would soar self-propelled. One of his kites lifted Lt. Thomas E. Selfridge, another aviation pioneer, 168 feet above the waters of Great Bras d'Or Lake in December, 1907.

Often, during high winds, the kindly white-bearded scientist would strike out to add his weight to the long line reining in one of his hacking cloud-scrapers. The lad on the right is his grandson, Melvill Bell Grosvenor.

↓ **Touring Russia in 1913, Dr. Grosvenor Photographed the Monastery of Miracles**

"Young Russia," the editor's account of his travels in the huge but little-known land, appeared in the November, 1914, issue of the National Geographic, illustrated with 71 color and black-and-white photographs by the author.

In 1928, Dr. and Mrs. Grosvenor again toured Russia via the Trans-Siberian Railway, seeing firsthand the contrasts wrought by the Russian Revolution.

The Monastery of Miracles, inside the Kremlin walls, was Moscow's richest and most celebrated 40 years ago. Tsar Boris Godunov cast the colossal bell, but no building could support its 200 tons.

Lhasa Photographs Published in 1905 Marked a Magazine Milestone

In January, 1905, the National Geographic carried 11 picture pages on Lhasa, Tibet's mysterious capital. Such unprecedented pictorial coverage aroused enthusiastic response (page 65). Here the Dalai Lama's palace, the Potala, looked about as it does today.

"First Meeting of North and South Poles": Amundsen Receives Society's Special Medal

Robert E. Peary, center, made the presentation in Washington on January 11, 1913. Earlier he had been awarded the Hubbard Medal and Special Gold Medal for his Arctic exploits. Mrs. Peary, at extreme left; British Ambassador James Bryce next to Peary.

Harris & Ewing

← A Youthful Salt Acquires Know-how from a Seasoned Skipper

Dr. Gilbert Grosvenor, a charter member of the Cruising Club of America, sails his 54-foot auxiliary yawl *Elsie* off the Nova Scotia coast. His pupil is his grandson, Alexander Graham Bell Grosvenor, now Lt. (jg.), carrier jet pilot, U. S. Navy.

As co-author and photographer of "Mid-shipman's Cruise" in the NATIONAL GEOGRAPHIC for June, 1948, Lieutenant Grosvenor became the fifth generation of his family (Hubbard-Bell-Grosvenor) to contribute to The Magazine.

Melville Bell Grosvenor, 1933

The Grosvenor Medal Is Awarded to Its Namesake

On Dr. Grosvenor's editorial Golden Jubilee, May 19, 1939, the Trustees bestowed on him the first Grosvenor Medal "for outstanding service to geography." Dr. Charles F. Kettering made the presentation.

National Geographic Photographer Robert F. Sisson

← Air-minded Grosvenors Span the Pacific

On board the China Clipper, Dr. and Mrs. Grosvenor were the first couple to fly as paying passengers from San Francisco to Hong Kong, May 8-14, 1937. The Manila-Hong Kong connection, last link in Pan American Airways' pioneer transpacific air route, had opened only the week before.

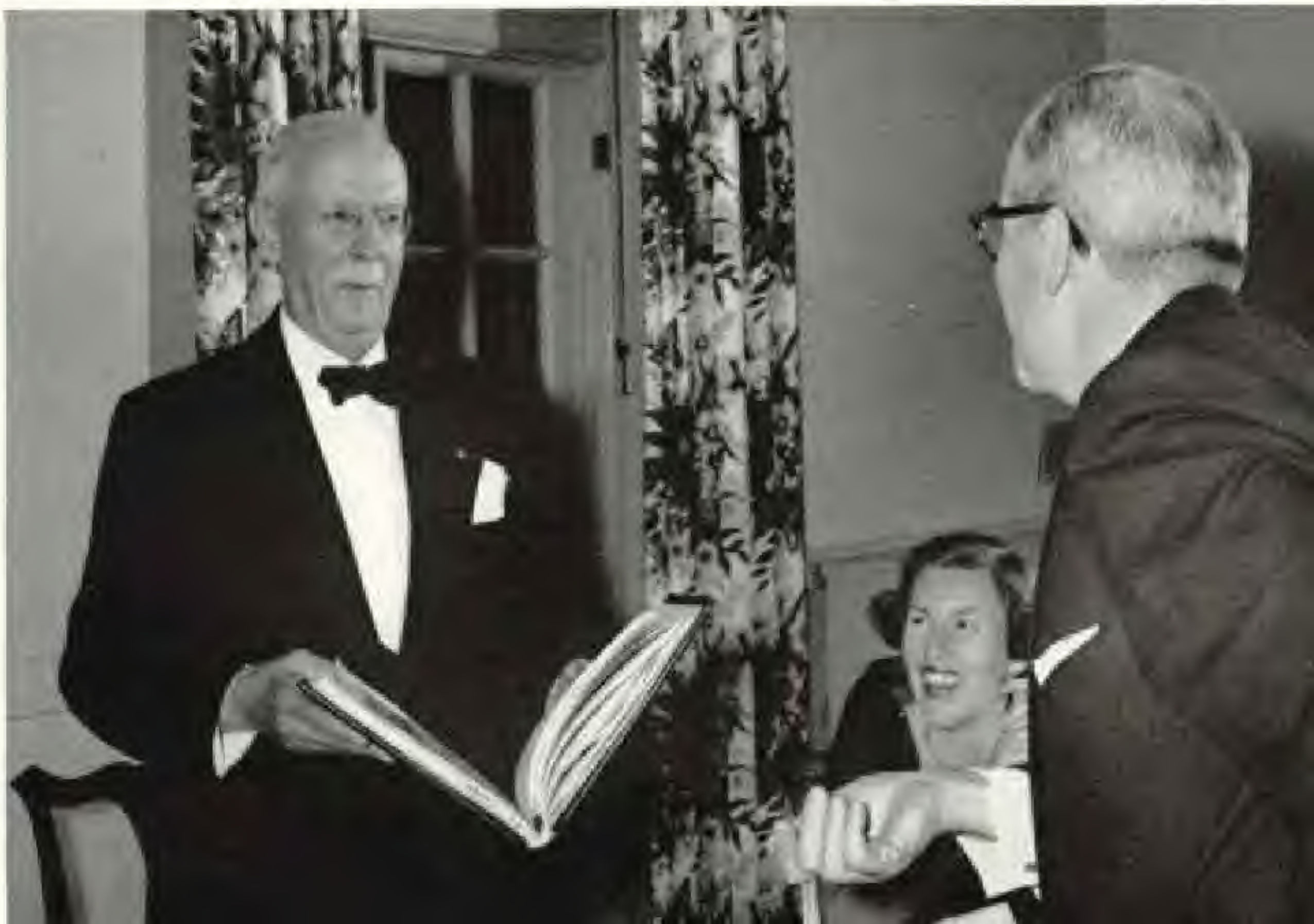
With her father, Alexander Graham Bell, Mrs. Grosvenor made her first visit to the Far East in 1898. On a three-months African trip in 1952, the Grosvenors flew 125 hours.

President Coolidge Presents the Hubbard Medal to Explorer Byrd

Nine Presidents of the United States have taken part in The Society's proceedings. On June 25, 1926, Comdr. (now Rear Admiral, retired) Richard E. Byrd was honored as first man to fly to the North Pole. Dr. Grosvenor and Mrs. Coolidge sit at right.

To "The Chief": Colleagues Tender an Album of Felicitations

Dr. Thomas McKnew presents the leather-bound portfolio, signed by all of the 848 Society employees, at a Board of Trustees dinner honoring Dr. and Mrs. Grosvenor and Dr. and Mrs. La Gorce. Mrs. Melville Bell Grosvenor smiles her delight.



NATIONAL GEOGRAPHIC SOCIETY

SIXTEENTH AND M STREETS NORTHWEST, WASHINGTON 6, D. C.

ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purposes for which it was founded sixty-six years ago, the National Geographic Society publishes the National Geographic Magazine monthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material The Magazine uses, generous remuneration is made.

In addition to the editorial and photographic surveys constantly being made, The Society has sponsored more than 100 scientific expeditions, some of which required years of field work to achieve their objectives.

The Society's notable expeditions have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus. By dating the ruins of vast communal dwellings in that region, The Society's researches solved secrets that had puzzled historians for 300 years.

In Mexico, The Society and the Smithsonian Institution, January 16, 1939, discovered the oldest dated work of man in the Americas. This stone is engraved, in Mayan characters, November 4, 291 B.C. (Spinden Correlation). It antedates by 200 years anything else dated in America, and reveals a great center of early American culture, previously unknown.

On November 11, 1935, the stratosphere flight of the world's largest balloon, *Explorer II*, sponsored by The Society and the U. S. Army Air Corps, reached a world-record altitude of 72,395 feet. Capts. Albert W. Stevens and Orvil A. Anderson took aloft a ton of scientific instruments and obtained results of extraordinary value.

A notable undertaking in the history of astronomy was launched in 1949 by The Society and Palomar Observatory of the California Institute of Technology. This project will photomap the vast reaches of space and provide for observatories all over the world the most extensive sky atlas yet made.

In 1948 The Society sent seven expeditions to study the sun's eclipse on a 5,320-mile arc from Burma to the Aleutians.

A Greek cargo ship sunk in the Mediterranean 2,200 years ago was found and investigated in 1952-54 by the National Geographic Society-*Calypso* Marine Archeological Expedition led by Capt. J.-Y. Cousteau of the French Navy.

The National Geographic Society and the Royal Ontario Museum in 1951 explored and measured newly found Chubb meteor crater, 11,500 feet in diameter, in northern Quebec.

The Society and individual members contributed $100,000 to help preserve for the American people the finest of California's sequoias, the Giant Forest in Sequoia National Park.

One of the world's largest icefields and glacial systems outside the polar regions was discovered in Alaska and Yukon by Bradford Washburn while exploring for The Society and the Harvard Institute of Exploration in 1935.

MORE REASONS TO GO ON THE B & O Among the many railroads which are placing new equipment in their crack trains, to make them even more inviting, comfortable and safe, is the Baltimore and Ohio Railroad.

We have recently delivered to the B & O a group of duplex roomette-bedroom cars built of stainless steel. You can enjoy their quiet, smooth ride, their all-'round luxury on such famous trains as the Capitol Limited, the National Limited and the Diplomat.

While providing the newest for long-distance travelers, the B & O has also brought greatly improved service to commuters in Pittsburgh, Washington and Baltimore with Budd self-propelled RDC rail diesel cars.

The B & O typifies the new philosophy of railroading, which recognizes that when you provide attractive equipment and fine service, people prefer to ride in trains.

The Budd Company, Philadelphia, Detroit, Gary.

Automobile and Truck Bodies and Wheels, Railway Passenger Cars

Budd

PIONEERS IN BETTER TRANSPORTATION

LEADERSHIP DEMANDS

TODAY'S MARK

World-renowned as...

LOCKHEED

Constellation and Super Constellation

Airline passengers remember, with confidence,
these facts of leadership of the
Lockheed Constellation family of air transports:

FIRST with powerful Wright turbo-compound engines.

FIRST in scheduled non-stop transcontinental service.

FIRST pressurized transcontinental and transocean airliner in the 340 m.p.h. class.

FASTEST across the North Atlantic.

BIGGEST air transport in service—with room to accommodate 5 commodious separate cabins, including a luxurious club lounge.

UNSURPASSED comfort, luxury, decor and appointments—with interior specially created for the turbo-compound Super Constellation by world-renowned designer Henry Dreyfuss:

Most advanced air-conditioning.
Most air circulation per passenger minute.
Widest aisle in the roomiest main cabin.
Most lavatory facilities.

UNSURPASSED in airline preference. A new Super Constellation airline starts service every month this year and into 1955.

UNSURPASSED in significant city-to-city timesaving to passengers—product of added speed.

Speed is useful only when it means practical timesaving, with at least equal dependability and comfort.

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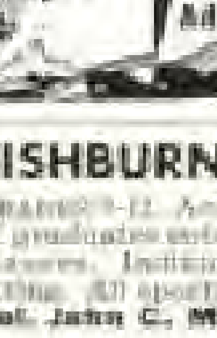

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